

A N
E S S A Y
O N T H E
C O N T E N T S A N D V I R T U E S
O F
D U N S E - S P A W.

In a LETTER to my Lord -----

-----*Nunc ego mitibus*

Mutare quæro tristia ; -----

HORAT. Lib. I. Ode 16.

By FRANCIS HOME, M. D.

E D I N B U R G H:

Printed by R. FLEMING,
For A. KINCAID and A. DONALDSON.

M. DCC. LI.

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PART I.

SECTION I.

MY LORD,

ACCORDING to your command,
I send you the following papers.

Your lordship may remember, that the discourse happened, one night, to turn upon *Dunse-spaw*. You made, then, a very just observation: That, if it had no medicinal virtues, it did not deserve to be in vogue: and, if it had any, 'twas pity, that, what was, in itself, good, should have no better support, than the tottering foundation of fancy and mode. Your lordship, then, asked me, to give you some account of that water. I promised, so far as I was able, to do it.

I COULD,

I COULD, no doubt, have formed, at that time, a pretty combination of steel, sulphur, and salt ; and have made the hypothesis account for all the effects of the water. I should, at last, perhaps, have given credit to it likewise, and fallen down before my own idol-notion. But had I endeavoured to make your lordship do the same, you would not, I know, have been so hasty in the worship. You would have expected proof. You would have asked to see the experiments, on which the plan had been formed. You would have, naturally, found out the laws of sound inquiry. You would have shown us, that good sense and philosophy are very nearly allied.

FOR this, my lord, is the road, that philosophy points out to its pupils. She allows but of one way to come at truth. She orders us, from known effects, to investigate unknown causes ; and, from particular causes, to proceed to more general ones, till we arrive at the most general. Thus, from repeated

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peated trials and observations, certain conclusions are drawn ; and the eternal and unchangeable properties of bodies evinced. This is called the *analytic* method of proceeding. And so true it is, that this is the only road for beings of our abilities to proceed in, that we neither do, nor can determine of any one effect in nature, unless from what we have seen before, in the like case. What our great moral poet, so justly, observes of God and man, may, with equal justice, be extended to the whole of creation :

* *Say first of God above, or man below,
What can we reason, but from what we know ?*

WHEN the summit is once gained, we have liberty to return. Having found out the cause, it is then allowed us, to explain, from it, all the effects and phænomena that appeared in all its different circumstances. This affords the imagination enough of play.

So

* Pope's 1. ethic epist. line 17.

8 AN ESSAY PART I.

So far is fancy from being damped by philosophy, that it seems to arise, with double force, from the *synthetic* method: for so the latter is called. But we must take care that it is the latter, else, how shall we know, that the whole is not a plan of airy thought, which may be afterwards overturned by experiment!

It is the neglect of this rule that has done so much harm to philosophy, and made it so variable, since the beginning of the world. Self-conceit prompted men to give the world complete systems. The method of experiment was too tedious for that purpose. They applied to their own fancies; and there formed, and combined those principles and laws, that were to answer every effect. Nature was immediately concluded to be the same with the workings of their brain. They imposed on themselves; they imposed on the world: but not long. Another scheme, that happened to suit the age better, appeared, and the

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the former was laid aside. Thus, philosophy, or rather opinion, for it deserved no other name, behoved to be continually on the change.

OUR senses, my lord, are designed for the uses of common life. They are formed to observe the out-lines only of nature's works, but not her finest strokes. It is not necessary for our happiness that they should: nay, it is necessary that they should not. Experiments then, which are the objects of our senses, and managed by them, can carry us no great length in knowledge, if not assisted, and extended by the force of reason. 'Tis thus, that we are allowed to carry our thoughts beyond experiments; and by the light which these trials throw over the varied works of nature, form some judgment of their undiscovered parts,

* *Ita res accendent lumina rebus.*

otherwise we should make but very slow ad-

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vances

* Lucret. lib. I,

vances in natural philosophy ; and be always, as a late author justly says, laying foundations, without attempting to build on them. By these analogical reasonings, others are led to inquiry, and may be so happy, as to discover experiments to illustrate them ; or, in their search, find other truths more useful.

BUT here great caution is necessary. We ought never to trust to reason alone, where experiment can have place : and tho' the latter cannot immediately be of use, yet we ought never to have it out of our view. When it refuses to be of the party, 'tis better to act the sceptic, than deceive ourselves and others ; and be at last, perhaps, confuted.

MINERAL waters, as parts of nature, are fit objects of natural philosophy ; and all inquiries into them ought to be guided by the same laws. Our business is to trace their principles from their effects. When
these

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these are once ascertained, we may safely, then, account for all the rest of their effects and operations on the human body.

It is but of late, that a regular scheme of inquiry has been projected. In the beginning of this century, *Hoffman* published those admirable treatises on the *German* mineral waters. There is the same objection against the writers † before him, that *Horace* had against bad poets,

* *Infelix*

† Du Clos is, still, reckoned the best writer on the mineral waters of France. His experiments are too few, and too general to give rise to any certain conclusions. Besides they were made at Paris, and not at the different fountains, which is a considerable objection to them. He falls likewise into some errors of chymistry. His work, however, is a good general collection, and wrote distinctly. The experiments deserve our credit the more, as they were performed before the royal academy of sciences.

BLONDEL, on Aix waters, gives good rules with regard to drinking and bathing; but his examination is lame, and shews him to have been no chymist.

BRESMALL, in his Hydro-analysis of Aix waters, discovers neither the physician nor chymist.

CHROUET,

* *Infelix operis summa, quia ponere totum nescit.*

THAT *totum*, that whole, without which no work can be complete, is wanting in their performances. To remedy this, that great physician and chymist has laid down the †
general

CHROUET, in his *Connoissance des eaux minerales d'Aix et de Spa*, tho' he follows no plan, yet is very ingenious; and has given us some curious and accurate experiments. His reasoning seems just. He appears to be the best writer on the Spaw-waters.

LISTER has but very few experiments: even those are in no order, and found to be mostly false by future examination. His reasoning is not much better, and generally so obscure, that it cannot be understood.

GUIDOT, in his treatise on Bath waters, follows no plan; has few experiments of any consequence; and seems not acquainted with the chymical properties of bodies. He is so far to be commended, as he relates some histories of cures.

BOYLE, in his short memoirs of the natural experimental history of mineral waters, affords many good hints, especially as to their medicinal properties. Yet several of the heads of inquiry he proposes can never be reduced to practice.

* Horat. de art. poet. lin. 54. † *Opuscula varia, de aqu. miner. earumque salutari virtute. Examen aqu. mineralium, observ. chymic. lib. 2. observ. 32.*

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general method of proceeding; and illustrated his scheme, by an accurate examination of the most celebrated waters in *Germany*.

BUT still the out-lines only were drawn. The finishing was reserved for a * late author. He has gone thro' the different steps of inquiry; and shown, how accurate they are, in his analysis of Scarborough-water. Had we been favoured, with as just an account of its effects, on healthful and morbid bodies, and of all its medicinal circumstances, as he seems to have once intended, the history of that water would have been complete.

A THOROUGH knowledge of the contents of mineral waters, gained from an accurate inquiry, is of great advantage to medicine. The physician is led, by it, to prescribe, with a greater degree of certainty. He sees where, in certain circumstances, some of their principles may do harm; and obviates
that,

* Dr. SHAW's inquiry into Scarborough Spaw-waters.

that, by dispelling, or correcting them. He sees by what principles the cure is to be effected, and may often increase those according to pleasure. His practice is built on the surest foundations, those of reason and experiment.

BUT medicine does not receive all the advantage. Natural philosophy has, likewise, its share. We learn, from the ingredients, what fossils lye in the neighbouring parts; and, from the examination of the contents of mineral waters, may be led to many useful discoveries. Some particular * substances are washed from the interior parts of the earth; these, we never, perhaps, had seen produced, in a natural way; and, therefore, thought they were not the product of nature. We find, in the hot waters, a species of heat, very † different from that produced by

* ALKALINE salts, such as are found in most of the mineral waters of Germany. Neutral purgative salts.

† THE thermæ affect the sensation of touch, less than common water heated to the same degree, by the thermometer.
Their

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by every kind of fire, which we have seen above ground. By means of these waters, we hold a correspondence with the more central parts.

' THE subject that we are going to enter on, is none of the most entertaining. Your patience, my lord, will be fully tried, before you get to the end; if ever you arrive that length. Yet the power of truth is, sometimes, very strong. Your lordship has heard of men, who have preferred a dry proposition of *Euclid* to the humours of Sir *John*, or the squire; and of a great philosopher, who had no pleasure in the *Eneid*, but from the truth of its geography.

SECT.

Their action, in hardening or softening vegetables, put into them, is, sometimes, opposite to that of common water. They continue longer hot than common water; for the Bath-water is said to retain its heat sixteen hours, in frosty weather. They take as long time, as cold water, before they can be brought to boil over a fire.

S E C T. II.

EVERY mineral water must flow thro' the neighbouring parts: it may be tinged by them. We know that the mineral beds, which alter the water, are, often, found not far from * the place where it breaks out. If the same bodies, that the water contains, are discovered near the well, it is probable, that they have a share in the formation of the mineral-spring. A previous examination, therefore, of the situation and soil, is absolutely necessary.

THE well is situated in a valley, which lyes a short mile on the south-side of *Dunse*. This bottom is washed by a brook, that runs from west to east. On the south-side of it there is a bank, that has the same direction. The brook, making a circular turn to the north, leaves a piece of ground between

* ROCAS, a man of character, relates, that, following a hot spring under ground, he discovered, in a few days, the mineral bed, where the water turned warm; and beyond that found it cold.

I. SECT. II. ON DUNSE-SPAW. 17

twixt the bank and itself. In this spot the well lyes, just at the bottom of the bank, and about thirty paces from the brook. The pipes, out of which the water issues, are about three foot higher, than the surface of the brook, in the summer time; so that none of its water, probably, ever gets into the well.

THE old well, that was first discovered, in the 1747, by some people straying that way, is close by the side of the brook. It was subject, sometimes, to be overflowed; and, therefore, it was thought proper, last year, to alter its situation. As it was probable that the mineral-streams came from the bank, a ditch was dug along the bottom of it, to catch them: but on carrying it further west, than the well is situated, at present, none could be found. There are several reasons, however, that lead me to think, that those streams, which supply the well, come from this bank, but lying deep, the ditch could not reach them. On digging

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north-

northwards, from the bank to the rivulet, the streams were found in great plenty oozing out from a sandy bottom. These being collected into one reservoir, whose sides are secured with clay, and its bottom with stones, constitute the well. The streams, that supplied the old well, have been caught, because it separates but little water now. The water of the new well is stronger than that of the old.

THE bank is about twelve foot high. The first *stratum* is of earth, and is six foot thick. Next comes a foot and a half of clay marl. The rest is a sandy soft stone, that effervesces a little with vinegar. On calcining * this stone, some particles were attracted by the magnet, and discovered themselves to be iron. The marl deserves our consideration: but it will come better in † under the article of earth.

THE

* Keeping it in a strong fire for some time.
Part 2. Sect. 5.

† Vid.

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THE sun can have no effect on the water, as the well is covered with gravel. No winds can easily reach it, but the north west and east, which blow along the channel of the rivulet. It is necessary to mention its situation in respect of the winds; for these have been observed to affect, greatly, all waters. *Hippocrates* † has long ago made this observation. It is very remarkable in the spaw-waters: insomuch, that the *Ligeois*, whose daily bread depends on the bottling of it, suspend their labour, when certain winds blow. Those waters, that are, thus, affected by the winds, must run, I imagine, near the surface, for a little way, before they appear; and, according as the ground is more, or less, opened, the volatile parts of the water are more, or less, dissipated. This is the only account, my lord, I can give you of a phenomenon, neglected by all the writers, yet known to every water-carrier about the Spaw. Last summer some imagined they perceived *Dunse*-water stronger in the westerly,

† Hippocrates de aere, aquis et locis.

ly, than the easterly winds. But with the former there was a long tract of dry weather; and, with the latter, rain came. As the water is, evidently, affected by dry and rainy weather, the change was, more probably, owing to this, than to the alteration of winds. Length of time, alone, can determine the truth of such observations. The easterly winds blow just against the pipes, and may, perhaps, penetrate and affect the water. If this is observed to be the case, it may be, easily, remedied.

THE north pipe pours out forty two pounds of water in a minute, and the south thirty six, in the same time. This makes in the whole seventy eight; so that, in twenty four hours, it separates 112,320 pounds.

THERE is a bluish scum, or pellicle, appears, in great quantity, on the surface of the old well. The same is seen, where the water of the new well stagnates, or when allowed to stand at rest in any vessel. There are no
fumes,

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fumes, or volatile parts, to be discovered, any where on the stones, that ly over the old well. There is an okery red matter deposited all over the bottom. So that the stones, on which the water falls from the pipe, are tinged with a red colour. The glasses, that are in use at the well, soon, gain a dusky yellowish colour, from the subtiler parts penetrating, and remaining there. The corks of bottles, that contain the water, are, commonly, turned black.

THE water, when taken up in a glass, sparkles a little, and emits a few air bubbles. Some of them rise two inches above the water. Air, then, is, already, discovered to be one of its principles.

ITS colour is like fine rock-water. The smell and taste seems, to some, entirely ferruginous, and to come from the mineral; to others, a little on the gun-powder; to most, very pleasant,

IT has been an uncontroverted opinion, since the days of *Hippocrates*, that the heaviest

viest water is the worst, and the lightest the best. This is a good general rule as to common water ; tho' even, there, it meets with some exceptions. Snow water is the lightest of all, and, perhaps, the most unwholesome. Its unhealthful effects appear too plainly on the inhabitants of the *Alps*. But this rule is still liable to more objections in mineral waters. Many of them, we find, are heavier than common water. Most of them would, perhaps, be so, if it were not for the great quantity of air they contain. Nor is it at all surprising, that the weight of water should be augmented, by minerals, and fossils, that surpass it, so much, in their specific gravity. A great part, nay the whole of their medicinal virtues, may depend on these weighty particles. It will, afterwards, appear, that the weight of *Dunse*-water is owing to some fixt steeley and terrestrial particles ; for, on their separation and falling to the bottom, the elemental water shews itself to be very light..

* *Hoffman,*

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* *Hoffman*, observing that the mineral waters of *Germany* were lighter when just taken up, than after they had been kept some time, imagined that all experiments, to discover their weight, were fallacious. The hydrostatical cylinder he used, that has a neck marked with different degrees, is, indeed, not the most accurate instrument. He imagined its descent was hindered by an expansive aëreo-ethereal principle in these waters, that, by endeavouring to take up a greater space, gave them a false lightness. I confess, my lord, this reasoning does not appear to me so conclusive; for, I imagine, this expansive principle, acting in opposition to gravity, must, soon, have its action, upwards, destroy'd; and, consequently, a balance and equilibrium of the whole mass will, immediately, follow. The real air-bubbles, that mount up, striking, with a force, the bottom of the hydrostatical glass, immersed in the water,

* De principiis et virtutibus præcipuorum medicamentorum Germaniæ fontium, parag. 33. And, de fontis Spadani, et Swalbacensis convenientia, parag. 14.

water, must hinder it, in some measure, from sinking. This ought, indeed, to be considered: nor should the gravity of any water be measured till these have expended themselves. After this, it will admit as much certainty, as any other fluid. The spherical glass with scales is, certainly, the best instrument.

It is, likewise, necessary to examine the degree of heat in all mineral wells; for, from this, alone, we distinguish them into *Thermæ* and *Acidulæ*, or, in other words, hot and cold waters. The other distinctions, that are given, by authors, from different salts, metals, or sulphur, are very inaccurate; because all the three may, and do, sometimes, exist in the same water. On the 16th of *June*, about half an hour after three in the afternoon, when the atmosphere was heated to the 68th degree of *Fahrenheit's* thermometer, the mercury, on putting it in the well water, fell to the 59th degree. A spring, at a little distance, on
the

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the other side of the brook, that was exposed to the sun, reduced the mercury to 54 degrees: on the 3d of *July*, which was a cloudy day, the same experiment was tried over again. In the atmosphere, the mercury stood at 72 degrees; in the mineral well at 59; and in the spring at 54. Thus, by both these trials, *Dunse*-water appears 5 degrees hotter than a spring exposed to the south: nor had the alteration of the atmosphere any effect on either of them, About the end of *October*, after it had froze some days, and the standing pools were covered with ice half an inch thick, the mercury, in the thermometer, immersed in *Dunse*-water, stood at 48 degrees. This spring appears, therefore, to have a certain degree of natural heat, independent of the atmosphere; and deserves to be classed betwixt hot and cold *Spaws*.

THE question, how the *Thermæ* receive their heat, seems scarcely yet well resolved by naturalists. It has been attributed to hot

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vapours,

vapours, mixing with these waters ; to a violent motion in the water below ground ; to its meeting with a calcarious earth ; to putrefactions ; to fermentation of opposite salts : but all these accounts are without any shew of reason. Some have made actual fire the cause of it, from observing volcano's in different parts of the earth ; in *Iceland*, as well as *Italy*. Those, near the volcano's, may, perhaps, be of this kind ; as that in the *Campo Volcani* betwixt *Puteoli* and *Naples*. But, we know, this cannot be the case with the more distant ones : for actual fire never can subsist without a communication with the external air. Others, with more reason, attribute the heat to the accidental meeting of sulphur, steel and water ; for, these ingredients, mixed in a certain proportion, produce such a degree of heat, as often ends in a flame. This may be allowed to be the case in sulphureous waters, but can never be admitted in those that have no sulphur. Some hot waters there are of this kind. *Borçet*, which is the hottest
at

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at *Aix*, and takes, if I remember right, nine minutes to boil an egg hard, contains, as we are told by writers, no sulphur. Besides; as vitriol of iron is always got, from the materials, when joined by art, we ought to expect it, likewise, from those mixed, in the earth, by nature. But none has, ever, been procured from these sulphureous *thermæ*.

THE most rational account of this affair seems to be, the natural heat of the more central parts of the earth, communicated to these waters, that rise, directly, from the deeper parts. That the earth has a natural heat of its own, distinct from the external heat of the sun, is very certain; for we find, in the bottom of mines, a much greater degree of heat, than there is at the surface when the weather is cold: the deeper we go, the heat increases the more. Whether this is owing to any attrition about the central parts; or to some other cause, I shall not pretend to determine. But it seems, evidently, to be a
heat

heat without a flame, and of the nature of that, which is formed by the attrition of hard bodies.

THE small degree of heat, in *Dunse*-water, may be accounted for from another cause. When steel is corroded by the acid of vitriol, we observe a considerable heat arise. Other bodies, that dissolve steel, may have the same effect.

WE shall have occasion, afterwards, to show, that steel is dissolved by water. To discover whether any heat was produced by the meeting of these two bodies, I put, on the 19th of *December*, two ounces of common water, and an ounce and an half of the pure filings of iron into one vial, and two ounces of water into another that was of the same size. These two vials were corked, and set together, in the coolest part of the room. Next morning, a thermometer being immersed in the vial, in which the iron and water

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ter were contained, the mercury stood at the 52 degree; when put into the vial where the water was, the mercury fell to the 51 degree. In the evening the mercury stood at the 54 degree in the former, and at 53 in the latter. Next morning the contents of both vials were of an equal heat. The water, in which the steel was infused, was now of a pale red. This last water I poured out, and put in as much fresh. In the evening the infusion of steel was a degree hotter than the water alone. I, then, added to the former another half ounce of the filings of iron, and to each vial two ounces more of water. Next morning the infusion of steel was an half degree hotter than the water in the other glass. The day after the mercury stood at the 48 degree in the water, but arose to the 50 degree, when immersed in the infusion. These several trials incline me to believe, that a small degree of heat, such as that in *Dunse-Spaw*, may arise from the solution of steel by water.

THIS

THIS water is observed to alter, greatly, for the worse, in rainy weather ; owing, no doubt, to the rain, that falls about the well, mixing with the mineral streams, and so diluting them. This inconvenience might be obviated, by making the surface of the ground, in which the well is situated, slop to the brook ; or carrying the rain off, as it falls, by hidden drains.

S E C T. III.

THERE is a method, my lord, that chymists follow, to come at the knowledge of the principles of mineral waters, while they are, yet, mixt together. They apply to them different bodies, both simple and compound ; and, from the different effects of that application, form a judgment of the contents. We shall call this method, as it has not, yet, got a name, the proof by *Commixtion*.

THE

SECT. III. ON DUNSE-SPAW. 31

THE examination of the effects, that bodies have on one another, is the examination of the universe: for the whole system of material nature is carried on by the mutual operation of bodies. Its regularity is maintained by the constancy of these effects; which regularity must always subsist, while bodies are, what they are, at present. We are apt to neglect, or overlook those changes, that, every moment, present themselves to our eyes. It is, only, the uncommon, tho' not the less natural, that force our attention, and surprize us.

THERE is not, indeed, a more agreeable scene, in all natural philosophy, than the strange effects that are produced from the mixture of certain bodies. Some that are naturally cold turn * hot, upon their mixture, and burst into a flame, while others produce

* Sulphur, mixed with filings of iron, and baked into a paste with water, will, if covered with earth, take fire. Spirit of nitre, poured on any distilled vegetable oil, raises, instantaneously, a flame. The regulus of antimony, mixed with sublimed mercury, will, often, take fire.

produce the intensest degree of * cold that we know, tho' separately they contain no great degree of it. Between some there is a strong attraction; while others † repel, with such force, as to endanger the lives of these present. Some have effects in a ‡ *vacuum*, that they have not in the air.

THERE can be no objection to this method of proceeding, by experiments of commixtion, as it depends on the unchangeable constitution of bodies; if the effects, resulting from it, are, justly, and accurately, ascertained. 'Tis true, some particular substances may be there, tho' the experiments of commixtion

* AMMONIAC salt, managed in a certain way, produces an intense degree of cold. Spirit of nitre, poured on ice, makes it much colder.

† IF brass in fusion is thrown into water, or a drop of water allowed to fall on it, the whole is scattered about, with great force, and horrid noise. The effects of this experiment seem greater than the explosion of gun-powder. But, happily, it can never be made use of to the destruction of mankind.

‡ SPIRIT of nitre and filings of iron fulminate in vacuum.

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mixture do not discover them. They may exist in so small a quantity, and so diluted with water, as not to have the degree of proximity requisite to produce their usual effects. But this, only, leads us to be cautious, how we deny their reality when they do not appear. It does not make the determination less certain, when they do. If we are at pains to fix the constant effects of these bodies, our judgment must be as certain and unchangeable, as the laws of nature.

How much the effects of these very common experiments stand in need of being fixed, every one, that has looked into the authors on mineral waters, must have observed. There is such a confusion on this subject, that, from the same experiments, very * different consequences are drawn. To be as-
E fured

* I shall only mention one instance of this among many. From a lactescency, or sediment, on mixing oil of tartar p. d. with a mineral water, some have concluded, that it contained nitre; others sea salt; others sulphur; others calcareous earth.

ured of a just conclusion, we must be assured of a just experiment on bodies separately. It is necessary, therefore, my lord, to inform you of my intention in each experiment; describe what would happen, if certain bodies had been, there, in sufficient quantity; and explain, so far as I am able, the reason of these effects in compound bodies: for, in the simple, we can go no further than this; that such is the will of the Author of nature,

* *Hanc rerum seriem ligat,
Terras ac pelagus regens,
Et cælo imperitans Amor.*

As the contents of mineral waters are either different salts, minerals, sulphur, or earths; so these ought to serve as guides in our trials: and we shall accordingly examine them in that order. The experiments, that do not come under these heads, shall be considered by themselves.

I. SEA

* BOETIUS de consolat. philosophiæ, lib. 2. metrum 8.

SECT. III. ON DUNSE-SPAW. 35

I. SEA salt is, almost, the only one, that shows itself in the proof by commixtion. Nitre may be discovered by making flesh red, and when brown paper, dipt in the water and dried, becomes a match. But, to produce these effects, it must be in considerable quantity. Besides; it is doubted, by many, whether it can ever be found in mineral waters, as it is the product of art and not of nature. To this sentiment, however, I cannot agree. For the experiments on the mineral waters of *France*, performed before the academy of sciences, discover that salt; and, as there is nothing improbable, in supposing it to be washed from the surface of the earth, where we know it is formed, and, by that means tincturing a stream, I see no reason why we should reject it.

I. A SOLUTION of quick-silver in spirit of nitre formed, when mixed with *Dunse-water*, a white cloud, which, after some minutes, fell to the bottom in form of a white substance.

stance. The same happened with common well water. But no change was made on distilled water.

2. A SOLUTION of silver in spirit of nitre produced a milkiness or lactescency. The same happened with common well water. It produced no alteration on distilled water.

THESE two experiments give us, already, a great probability, that there is a mixture of sea salt in *Dunse-Spaw*; tho' not more, nor even so much, as in well water. The same experiment should, always, be repeated on common and distilled waters, that we may see, whether the change arises from the water itself, or its foreign contents. It is the nature of sea salt to precipitate silver, or quicksilver, When dissolved in spirit of nitre, by turning the solution into an *aqua regia*, which we know rejects these bodies, and dissolves gold alone. Whether this change happens, from a stronger attraction betwixt the spirit of nitre and sea salt, than betwixt that spirit

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spirit and the metals that it has, already, dissolved, or by some other power, is not yet determined.

IN making experiments with these and corrosive spirits, care must, always, be taken that the phials, which contain them, be stopp'd with glass stoppers ; for these spirits corrode cork, and so produce an oily-like substance, that swims on the top, and, being mixed with waters, gives a false milkiness to them. I was deceived myself, at first, in this way.

II. OF the mineral kingdom, copper and steel, alone, are allowed to tincture waters, because these metals, alone, are found, in the bowels of the earth, corroded by an acid. But I see no reason, according to this very plan, why lead should be excluded from that number, since it is so, easily, dissolved by all acids. It will appear, afterwards, that all the other metals may impart their subtile particles to water. Quick-silver may with justice put in its claim ; for we find it communicates

cates something to water, when shaken with it, that has, as a medicine, considerable virtues. But these questions we leave to be determined by future ages, which will have more facts to build on.

3. COPPER, when dissolved by an acid, is discovered on putting a piece of iron into the solution. The particles of copper are not so strongly attracted by the acid, as those of iron; they are therefore let fall, and, by degrees, covering the plate of iron, give it a copper-colour. Several springs in * *Hungary* discover a copper by this method. This experiment was tried with *Dunse*-water, but no change of colour happened to the iron. *Mof-fat* contains copper, in no inconsiderable quantity, but does not show any on this trial. It is, therefore, probably, not dissolved, there, by an acid; but exists in its natural form.

STEEL was the next object of my search.

4. THE

* Vide Hoffman. de elementis aquarum mineralium recte dijudicandis et examinandis, parag. 44.

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4. THE powder of Ballaustine flowers gave *Dunse*-water a purple colour. That of Sumach a brownish red. That of Pomegranate the same. That of Oak-bark a deeper. Green tea turned it purple. * A tincture of Galls struck the deepest purple. I found a certain quantity of the tincture was required to give it its deepest colour, and, when more than that was added, the colour turned lighter. Four drops of the tincture was the proper quantity to four ounces of the water; when forty was put in the same quantity, it was of a *Burgundy* colour.

IT is necessary, in order to compare the colours of different waters, that we should have some method of ~~finding~~ the colour. No words can, ever, convey the idea of these changeable shades. Nothing, but an exhibition of the same colour to the eye, can serve the purpose. This may be done with the
salt

* The tincture, I made use of, was an ounce of boiling water poured on a drachm of galls, and allowed to stand an hour, then strained thro' brown paper.

salt of steel. One grain of this was dissolved in sixty drops of common water. Six drops of this solution, added to four ounces of common water, in which was put, before, its proportion of the tincture of galls, struck, precisely, the colour of the mineral water. As the salt of steel, when rightly prepared, is always the same, a person in *China* may know the colour, in this way, as exactly as one at the well, and so compare it with the mineral waters there.

WHEN any water turns purple with these astringents, it is looked on as an undoubted mark of its containing steel. Nor, indeed, does there appear an objection of any force against this conclusion, seeing it is the only body known, on which these astringents have this effect. A late * author has given us a very ingenious theory to account for this phenomenon. He imagines, that these astringents have an absorbent power, by which they attract the acid that has dissolved the iron,

* Dr. SHAW.

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ron, and so leave the steely particles to float, by themselves, in the liquid: these being black must, necessarily, give their colour to the fluid. The same thing happens in making ink with galls, water, and coperas, which is steel dissolved by an acid. The galls attract or absorb the acid, leave the irony particles at liberty to exert their natural colour, and so produce ink. This reasoning he confirms by observing, that if oil of vitriol be added to any of these mixtures, made black with galls, they turn pellucid; because there is, now, more acid than the galls can absorb, and the remainder joins itself, again, to the steel.

WHAT the poet said, my lord, of human life, may be as justly applied to theories:

* *Nil est ab omni*

Parte beatum.

THERE is, generally, some little flaw, that renders the jewel of less value. I have never
F been

* HORAT. lib. 2. od. 16.

been able to discover any attraction, or absorption betwixt galls and acids. The experiment was made with both mineral and vegetable acids, but I never observed any attraction betwixt them, or that the acidity was, in the smallest degree, blunted by the galls. If it be said, that the acid may be attracted, without being blunted, then mineral waters, and ink should discover an acidity, after the galls have attracted the acid from the iron. But what seems, yet, a stronger argument against this theory, and shows, to the eye, that the acid is not concerned, is this: rub the filings of iron, galls, and distilled water, together, in a mortar, a black liquor, in half a minute, is produced. The reason then of this phenomenon in steel waters, I chuse, rather, to attribute to some change, wrought on either the steel, or galls, (for 'tis uncertain which) by the other, so that it is able to reflect the black or purple rays of light. What the change is, that makes them capable of reflecting these colours, seems a speculation

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culation too minute, for us, ever, to arrive at any degree of certainty with regard to it. We must, therefore, leave these theoretical points, for the more certain road of experiment.

Dunse-water turned some kind of brandy black, which, with another kind, it made no alteration. To alter the colour, I was told, was a proof that the brandy was good. On inquiry I was informed, that brandy was, often, brought home in oaken casks. The spirit, in that case, had drawn a tincture from the oak, and discovered it by its turning black with the mineral water. The longer time the spirit has been kept in the oaken cask, the deeper must the tincture be.

III. THE next experiments were made in pursuit of sulphur. This is, often, difficult to be discovered; tho', in the opinion of a great * Chymist, oftner suspected, than really existing

* HOFFMAN. de elementis aquar. miner. parag. 53. Paucissimæ enim calidarum hospitalium aquarum sunt, quæ sulphur vehunt,

existing in these waters. It may be, there, in different shapes: in its native form; or dissolved by an alkaline salt; as a volatile body; or as a fixt. The trials, to find out the fixt sulphur, come in, more properly, in another place.

6. If there was any volatile native, or dissolved sulphur, it would be found, sublimed,
on

vehunt; et si Aquisgranenses, et paucas forsan alias, exceperis, vix umbram ejus deprehendes. Sunt quidem plurimi, qui Carolinis, Wisbadenlibus et Emsensibus, sulphur affingunt, lepidam somnii a colore croceo, quo indusia alba in balneo inficiuntur, rationem cogentes, sed longe alia est hujus tincturæ ratio, et mihi tam felici esse non contigit, ut ex his plurimisque aliis sulphur eruere et denudare potuissem, licet summo studio et quæsitissimis artificiiis examen instituerim. Est quoque fons fœtens et inurbani admodum, ovorum putridorum instar, odoris, in confiniis Frankofurti ad Mœnum, et qui ab ipso perfluere putatur, in ipsa urbe, vernaculo vocant *den Faut-bran*. Hic egregia laxante virtute pollet, et in febribus ad sitim sedandam avide ab ægrotantibus hauritur: sed adornato curiose ejus examine, pariter nihil plane sulphuris in eo reperiri licuit. Notæ autem et characteres qui formalis sulphuris præsentiam produnt et arguant, sunt: si aquæ argentum fusco vel nigro inficiant colore, et post omnimodam liquoris exhalationem, concrementum relinquunt inflammabile, quod cum sale Tartari in hepar sulphuris tranfit. — Such is the opinion of as great a chymist as ever has been.

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on the stones, above the old well: but no such thing can be observed. Sulphur is collected, in this manner, at *Aix*, in considerable quantity.

7. A PIECE of silver was kept a month in the water, but there was no change of colour, when taken out. The *Aix*-waters, in a few hours, turn silver first brown, then black.

THIS change of colour in silver is the most certain criterion of a sulphur-water; and, where it does not happen, in a sufficient time, the existence of sulphur is to be much suspected. I was convinced of the truth of this by several experiments. Three grains of sulphur, dissolved by an alkaline salt, was mixed with five *English* pints of water. This solution was pellucid, and was so weak, that it had no sulphureous smell: yet, in two hours, it tinged silver brown. The same quantity of sulphur, in seven pints of water, made no change on the silver. Thus,
we

we see an inconsiderable quantity, even after it has lost its sulphureous smell, will discover itself by this experiment. A smaller portion than this scarce deserves our notice. What shall we, then, think of waters, that seem to have a sulphureous smell, and yet do not alter the colour of silver? This leads us to think, it is owing to some other cause.

NOTHING, that we know, can make sulphur dissolvable in water, but alkaline substances. It has been doubted, from this, by many chymists, whether sulphur could ever be found, in mineral waters, without an alkaline salt. And, indeed, not without reason; for the two famous sulphur-wells, *Aix* and *Geronster*, have both an alkaline salt. To discover whether this was the case with *Dunse-spaw*,

8. SPIRIT of nitre was mixed with it; but no change happened.

WHEN sulphur is joined with an alkaline salt, and plentifully dissolved in water, the
mineral

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mineral acids turn the solution milky. The reason given for this change is, That the alkaline salt is, more powerfully, attracted by the acid, than by the sulphur, to which it before adhered, and so quits it: the sulphur, left to itself, gives the liquid a milky colour, and falls, at last, to the bottom. But I must, freely, own, that on trying this experiment on such a strong solution of sulphur, first opened by an alkaline salt, that the mixture tinged silver in ten minutes, and turned a solution of silver, in spirit of nitre, brown; this strong solution of sulphur, I say, was not in the least altered by a mixture of the spirit of nitre. Thus far our endeavours to discover a sulphur have been unsuccessful.

IV. My next experiments were made to discover an earth.

9. A solution of sugar of lead in water was allowed to stand some weeks. A reddish tincture was, by this means, drawn from it,

it, which is much better than the simple solution; for that, being white, will give a false milkiness to every liquor. This was mixed with *Dunse*-water, and gave to it a reddish colour. In a few minutes a red sediment was precipitated.

FROM this experiment I conclude, that there is an earthy principle in this water. That this conclusion is just, appears from the following trials. The same solution, mixed with rain water, made no precipitation. In rain water I dissolved some common earth, and, after it had settled, poured the water off. Into this water the solution of sugar of lead was dropt: in a few minutes a red sediment was formed. The same experiment was repeated with the different kinds of marl, and it always succeeded in the same way: only there was a little difference in the colour of the different sediments.

THE theory of these experiments seems to land in this; That there is a greater attraction

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traction betwixt the absorbent earth, of which there is a good quantity in all common earth, and the acid, than betwixt this last and the lead; for the sugar of lead is a composition formed by an acid, corroding lead. That I might discover if this solution was affected by sea salt, some of that salt was dissolved in rain-water, and the solution poured on it. A milkiness and precipitation followed. According, therefore, to the different effects of this experiment, different conclusions are to be drawn.

10. OIL of tartar *p. d.* being mixed with *Dunse*-water, no lactescency happened, but a little whitish sediment was separated.

THIS shows, likewise, a terrestrial principle in the water. The following experiment is a proof of it. Some earth, dissolved in rain-water, was allowed to stand till it settled. The clear water was poured into a glass. This, on standing for some time, did not let fall a sediment: but when I dropt
G into

into it some oil of tartar *p. d.* a precipitation was made in two minutes. This experiment is, often, brought as a proof of sea salt; it, therefore, needs to be set in a clear light. When a considerable quantity of sea salt is dissolved in water, if oil of tartar *p. d.* is poured on the mixture, it, immediately, turns milky, and is, soon, divided into white clouds, which all mount to the surface like an oil: this, at last, falls down, and forms a white cloudy sediment. But sea salt must be in considerable quantity to have this effect. Thus, the success of experiments, to discover sea salt, or earth, seems very different. Oil of tartar *p. d.* makes no change on nitre dissolved in water, and therefore, it is surprising that it should, ever, have been brought as a proof of nitre. Nor does it affect a solution of sulphur, first opened by an alkaline salt.

V. 11. MY next design was to discover, if there was any acid, or alkaline principle, in this water. On mixing oil of tartar *p. d.* with

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with it, there was no intestine motion: therefore it contains no acid. Altho' all cold mineral wells are called *Acidulæ*, yet there has never any acid principles been discovered in them. *Hoffman* first set the world free from this mistake. The subtile spirit of the *German*-waters, that affects the palate with a kind of sharpness, led mankind first into that mistake. This must, generally, be the case, when the proof depends on the senses alone.

12. To discover if any of the principles were of an alkaline nature, distilled vinegar was mixed with it: no effervescence happened; only a few air-bubbles arose. Aqua fortis poured into it raised no intestine motion, but produced more air-bubbles. The same happened with spirit of vitriol. With oil of vitriol it effervesced a little; but nothing can be drawn from this experiment, as the same happened, on trial, with common water. Altho' there does not appear any intestine motion in these experiments, yet the separation of air-bubbles is a proof of something gently alkaline.

alkaline. This is confirmed by the following experiment.

13. Syrup of violets was mixed with the mineral and common water. The syrup mixed with the first was greener than with the last: for, it must be remarked, that this syrup, when diluted with water, always, takes a greenish colour.

VI. SOME general experiments follow.

14. To discover whether the water was of a soft or hard nature; I tried it with soap, and found, that soap was, easily, dissolved in it, when cold. I was told that this mineral water, after it had passed thro' the human body, and had been kept some time, washed like soap. The water, itself, turns linen yellow; an effect common to all steel waters.

15. To try if there was any thing in it hurtful to amphibious animals, a worm was
put

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put in the mineral water; it died in two hours. Another put into common water, for the same time, was not, in the least, affected.

16. Six minnows were put into a glass of *Dunse*-water: they seemed very uneasy, breathed hard; came to the surface; and, often, leaped over the glass. Two died in an hour and a half; other two in three hours; the rest seemed, at that time, very sick. When the water had lost its spirit, I observed that they recovered, and turned sick, again, on the addition of fresh water. This effect is common, so far as I know, to all steel springs.

My next trials were in the apothecary-way.

17. Two equal quantities of rhubarb were put into two separate phials. *Dunse*-water was poured into one, and common water into the other. After standing twenty four hours,

hours, the mineral water drew the deepest tincture. The same experiment was made with *Dunse*-water, after it had lost its spirit, but this tincture was no deeper than that with common water.

18. THE same trial was made with *sen-*
na, and the same thing happened.

19. BUT with *sassafras*, the taste, colour, and smell, were the same in both.

THESE experiments are, commonly, brought as proofs of an alkaline salt; for that, powerfully, dissolves the refine in these bodies. But, here, the diversity of colour can be attributed to no such cause. A volatile spirit seems, by the first experiment, to have the chief hand in it.

ITS effects on animal substances were next tried.

20. Upon equal quantities of flesh, equal quantities of mineral and common water
were

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were poured. It was hot weather, so that both, in two days, smelt strong. The flesh, in both, seemed of the same colour.

21. THE same experiment was tried with urine. The mineral, four days after, was a degree lower in the straw colour, but had a stronger smell.

22. WHEN the same trial was made on blood, the mineral drew a deeper tincture from it. After they had both stood six days, the mineral was still reddish towards the top, but the common water, altho' it contained more sea salt, was quite black. The first smelt but little; the other stunk abominably. *Dunse*-Spaw would seem, by this last, to be an enemy to putrefaction.

23. UPON milk warmed, it made no alteration. This is a very material experiment in all waters, as to their use. The curdling of milk seems, in mineral springs, to depend on their neutral salt. This is evident from
the

the *Scarborough-Spaw*. And now, my lord, enough, I think, is done in the way of commixtion : more would, perhaps, be tedious.

S E C T. IV.

WE ought not to rest contented with a view of mineral waters, when just taken from the well, and in their best condition. We should observe what changes they undergo by time ; what parts fly off ; what remain ; and what happens to these, both before and after putrefaction. This is a kind of natural analysis, that these waters undergo, by which we discover parts, that, otherwise, we could never have seen. It teaches us several truths very useful to medicine and philosophy. It has, hitherto, been too little regarded.

1. *Dunse-water*, exposed to the air, gathers a scum in a little time. Great plenty of this is found on the old well, and where the water of the new stagnates. I could never observe

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observe any on the water, when put in bottles well corked and waxed over. This might, perhaps, be owing to the carriage.

2. A RED sediment is separated, in great plenty, from the water, wherever it runs, so as to tinge all the stones red. The same happens when the water is bottled for some time.

3. AFTER the water has been kept twenty four hours, it loses its white colour, and turns, remarkably, bluish. The ferruginous taste is, then, gone; and the mineral water appears, to the palate, in no way different from common water.

4. IF the water is exposed to the open air, for twenty minutes, it takes but a very light colour with galls. When it had stood two hours and an half, no alteration was made on it by the tincture. The heat of the atmosphere was, then, at the 68th degree of *Farenheit's* thermometer.

H

5. SOME

5. SOME of it was kept, for half an hour, in a heat, equal to that of the human body. It took, then, no tincture from galls. Twenty minutes in boiling water, or, perhaps, much less time, destroys the tincturing quality likewise.

6. SOME bottles of *Dunse*-water, well corked and waxed over, were carried five miles from the spring. When opened the water took no tincture. I found, however, afterwards, that some of this tincturing principle could be retained, if the bottles, even unwaxed, were carried with their necks downwards.

THESE experiments shew us, that the steely principle, very quickly, disappears. Whether it flies off, or is changed, will be the subject of a future inquiry. This water seems to lose it sooner than any yet described. Authors, indeed, have been a little inaccurate in this point; our surprize must be the

SECT. IV. ON DUNSE-SPAW. 59

the greater, since, from this steely spirit, they deduce most of the medicinal virtues, that these waters have. * *Hoffman* says, "That the *Pyrmont* water loses, in twenty four hours, its power of striking a tincture with galls, when exposed to the open air." Yet we know, that this spirit can be detained, for years, in bottles well corked. † *Lister*, speaking of the *Bath*-waters, says, "That in frosty weather, they preserve, for a long time, their tincturing quality, but lose it, soon, in thaw: yet, when well bottled and corked, they preserve it for many days." ‡ *Dr. Shaw* tells us, "That *Scarborough*-water, exposed, loses its power of receiving a tincture from galls: yet it carries in bottles." But the time he has not mentioned. In another place, "nor does the mineral spirit, or light irony principle of the *Scarborough*-spaw water appear to be, extremely, light and volatile." There is a spring in *Misnia*, described by *Hoffman*, that seems to have

* De principiis et virtutibus præcipuorum medicamentorum Germaniæ fontium. † P. 233. ‡ P. 91. and 145.

have a spirit of equal subtilty with *Dunfespaw*. We shall have an occasion, * afterwards, to describe this last mentioned mineral water.

AFTER the steely principle has disappeared, the water seems, on trial, to be the same as to its other effects. It appeared to differ only in its specifick gravity. The same instrument, that I used before, weighed six grains more, after the oker was deposited, than in water where the principles were yet intire. Thus it becomes the seven hundred and fifty fifth part lighter than when first drawn from the spring; and the one thousand one hundred and thirty third part lighter than the brook-water,

THE *scum*, or *pellicle* gathered on the surface of the water, by a natural separation, deserves our consideration. Altho' it is a part, that must, immediately, strike the eye: altho' it is a part much used, in different diseases,
by

* Vid. part 2. sect. 7.

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by those that frequent mineral waters; yet, it has been, intirely, neglected by all authors. Whether they judged it too subtile, or too trifling a part, I know not. It is not, perhaps, so subtile, as to elude our experiments: and sure, that ought never to be accounted a trifle, which is so beneficial to mankind.

7. THE *scum*, when yet on the surface of the water, has a bluish purple colour; but, when taken off with a spoon, it turns, in that very instant, red. After it was carried some miles, the mixture appeared turbid and red. Being set down to settle, instead of appearing, again, on the surface, as was expected, it fell to the bottom in form of reddish pellicles floating up and down. After it had settled, the clear water was poured off. The red substance, that remained, was tried with a mixture of galls, but no change of colour happened.

8. THE remaining water that adhered was evaporated. The powder was of a light red colour,

colour, felt fat and a little gritty in the mouth, and seemed to have a ferruginous taste.

9. MIXED with galls and water, and allowed to stand twenty four hours, a red tincture was formed.

10. SOME of it was calcined in a crucible, for two hours; the loadstone, attracted the whole, after it came from the fire, and shewed it to be iron.

THUS its nature seems very simple, and easily discovered. A scum, like this, is observed in all solutions of iron, whether by mineral or vegetable acids, and in the tinctures of iron made with * water. It is formed by the subtiler particles of steel, carried up to the surface by the continual separation of air-bubbles. How minute they are, their application to the eye, without pain, plainly discovers. Their external effects on the human body show, evidently, that they must enter the

* Vide sect. 6. part 2.

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the pores, and, consequently, that they are much attenuated.

THE remaining part, that is, naturally, separated from the water, on standing; and is to be observed in bottles, after the water has been there some days, is called, by writers, *Oker*, *Rubrick*, or *mater ferri*. As the quantity, that I had occasion for, in the following experiments, could not be collected from bottles; it was gathered from the surface of the pebbles, on which the stream, from the pipes, falls.

11. THE oker, being dried and reduced to powder, was rubbed with water in a mortar, but the mixture would take no tincture with galls.

12. WHEN dried it appeared like brick dust, and tasted like fat clay. It melted in the mouth without being in the least gritty. Some small shining particles appeared in it. When viewed with a microscope, it appeared
an

an opaque body, without any distinction of parts.

13. IT did not effervesce, nor dissolve in distilled vinegar, or spirit of vitriol. Some writers alledge, that the oker of all steel waters effervesces with the last. This is found to be the case with the *German* waters: therefore, they conclude it is so with all others. The oker, that is separated from them, contains a portion of alkaline salt; and it is this part that raises a conflict with acids.

14. WHEN mixed with syrup of violets, it gave the mixture its own reddish colour.

15. BEING put on a red hot iron it sparkled, but did not burn blue, nor emit any sulphureous flames. In sulphureous water the oker is found to contain sulphur.

16. I MIXED some oker and ammoniack salt together, and sublimed them. The sublimed flowers were somewhat yellow and a
little

SECT. IV. ON DUNSE-SPAW. 65

little astringent. I, therefore, imagined that the steel was sublimed; for it mounts, when treated in this way, with the salt. But no martial tincture could be drawn from it with spirit of wine. The tincture was evaporated, but no iron was discovered by the magnet. As the end of this experiment seems to contradict the beginning, no conclusion can be drawn from it.

17. SOME oker calcined in a coal fire, for an hour, was much redder, and attracted by the loadstone: this was not the case before ignition. It was afterwards put in the strongest heat of a smith's forge for an hour. When it was taken out, there were a few dark-blue gritty particles loose, but the greatest part was fixt, like a metallic matter, to the bottom of the crucible, and appeared like melted iron: these were, forcibly, attracted by the magnet. Thus, the oker seems to melt into iron, with a degree of heat, that is not very intense.

18. THE calcined oker, mixed with galls and water, and allowed to stand twenty four hours, produced no purple tincture. The difference, betwixt this experiment, and that with the scum, is worth remarking ; and may depend, perhaps, on the minuteness of the steely particles, in the former.

THE oker has, generally, been looked on as the rust of the iron ; but its viscous taste confutes this opinion : nor does it appear, that the steel ever had an acid joined to it. There is such a resemblance both of figure and composition, betwixt it and the scum, that I am led to think them the same. The most plausible theory, with regard to it, is this. The particles of steel, that form the scum, are carried up to the surface of the water by the air-bubbles that are continually rising. They remain on this surface by a repulsive force, that is to be observed betwixt steel and water. By the continual addition of more particles the specific gravity of the scum is, at last, able to overcome the force of
repul-

SECT. IV. ON DUNSE-SPAW. 67

repulsion: then the scum falls to the bottom and becomes the oker. This happened to the scum, as I observed, when mixed with water. I have seen these red pellicles hanging down, in the water, from the scum, and just ready to leave it. These in their descent, thro' the water, carry along part of the salts, earths, and what other bodies there is in it. By this means, they must * differ in different waters;

* MONS. CHROUET is the only person, so far as I know, that has ever made any experiments on the oker of mineral waters. He has given us the composition of that found in the different springs of the Spaw.

THE oker of the Tonnillet is very red and tastes like sugar. It seems to contain some allum. When put on a red hot iron it burns like sulphur, and detonates with nitre. With galls it gives no tincture, nor is attracted by the loadstone till fused. No alkali is found in it when calcined.

THAT of the Geronster is yellow and tastes saltish. In five ounces of it he found two scruples of a bitter salt, neither acid nor alkaline, but easily, with a small heat, going into the latter class. When calcined it turned red, and was attracted by the loadstone. With galls it turned black. Some of it was boiled in water and oil of tartar, p. d. was put in; this turned it quite red. On adding warm water to this tincture, there was a precipitation of a white matter, that appeared

waters; be more impure than the scum; contain a less proportion of steel; and have a greater attraction and union betwixt their particles. They must, likewise, in some measure, discover the other contents of mineral waters.

S E C T. V.

THERE is no change, my lord, so common in nature, as that of bodies from an intire state to a corrupted one. All vegetables, whether *acescent*, *alkalescent*, *austere*, *aromatic*, *insipid*, *cold*, or *hot*, are liable to putrefaction; and, generally, end in it. Animal bodies are in a continual tendency to it;

peared to be sulphur by its acid fumes and detonating with nitre.

THAT of the Pohon is yellow and sharp on the tongue. Put on a red hot iron it has a ferruginous smell, and, after, made a tincture with galls. But it was not attracted by the magnet.

THAT of the Sauveniere has the same colour, but is sweet. It contains about the fourth part sulphur. When calcined it is attracted by the magnet. From five ounces a drachm of salt, like Tonnillet, is got.

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it; and, in this way, their vegetable aliments are turned into their nature. When the addition of fresh juices, the motion of the fluids, and the expulsion of the corrupted is, once, put a stop to by death, this change, then, goes speedily on.

AN end so very general, and so destructive in appearance, may lead a careless observer to think, that nature is plotting, by it, her own ruin.

* *Sic omnia fatis
In pejus ruere, ac retro relapsa referri.*

THIS may, perhaps, be the first reflection. But a further view will, soon, force us to alter our sentiments. Corruption is observed to be the parent of vegetation. By the influence of the air, the putrified body is recalled from that state; and constitutes, again, the bland juices of vegetables. This, then, is the circle, that nature has chosen to move in. To keep it complete, it is, wisely,

* Virgil Georg. 1. line 200.

ly, ordained, that all vegetable and animal bodies should, at last, end in this state; and their very dissolution be attended with benefit to mankind.

† *Quæcunque videntur*

Aliud ex alio reficit natura.

THIS natural process is not attended, with such a variety of circumstances in animal bodies, as in vegetable. Animals are, already, on the confines of putrefaction. But vegetables have a surprising change to undergo; and, therefore, the variety, attending it, strikes us the more. Your lordship has, no doubt, often, observed these changes, where a quantity of vegetables have been laid together to rot, or when a rick of hay has been stacked too green. I shall, therefore, only recall, to your mind, the principal circumstances attending it, and the alteration that is made by it. These are necessary to be known, in order

† Lucretius lib. I.

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order to understand the change in the mineral-water.

IF the soft recent parts of vegetables are, in the summer-time, heaped together, and the free circulation of air is obstructed, a sharp smell, still, however, their own, is first felt: they begin to be hot towards the middle: this increases, every day, more and more, in proportion to the pressure, moisture, and want of air. As the heat advances, they lose their peculiar smell; and gain a fetid one, with a horrid cadaverous taste. If the heap and pressure be great, and the moisture not over prevalent, the heat, often, bursts into a flame. When that does not happen, putrefaction runs its course, till the whole mass is changed into a substance, very disagreeable both in smell and taste. This is always the same, however different the vegetable matter be; and resembles corrupted animal substances.

IF

IF this putrified mass is examined by chymistry, it affords the same principles, that animal substances do, a fetid water, volatile alkaline salt, a thick stinking oil, and a pure earthy *residuum*; principles! very opposite indeed, to those it contained, in a sound state. There seems no difference betwixt putrified vegetables and animal matter. The effect, then, of this natural process is, to render the salts and oils alkaline, volatile, and fetid; and to reduce all substances, whether animal, or vegetable, to the very self-same principles.

To account for all these changes, theory seems yet deficient. The common opinion is, that they are owing to the air, inclosed in these bodies, raising, by the struggles it makes to get free, an intestine motion: and, by this, the salts and oils are attenuated and rendered volatile. But this is only putting the difficulty a step further off. The next question must be, What makes the air so fond of getting away? It is, generally, thought,
that

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that the action of the external air is necessary to this change. This appears to me not well founded. For, I find that water putrifies, when kept, from all contact with the external air, by good corks sealed over. The air-pump has led people into this notion. No putrefaction is observed, there, when the air has been exhausted. From this a general conclusion is drawn. But it is unwarrantable, as differing, in circumstances, from the common process. For, not only the external air is drawn off, but, with it, the internal likewise. Liquids lose it as the action of the air-pump goes on: and, if solids do not quit with it, directly; yet it will, immediately, escape, when unfettered, before it has wrought any change on the mass. There is something, in this affair, not well understood yet, nor, perhaps, ever will.

* *Multa petentibus*

Multa defunt,

K

is

* Horat. lib. 3. ode 16.

is a maxim, my lord, as true in pursuit of knowledge, as in pursuit of riches.

WATERS, when stagnating and exposed to heat, undergo this change. Those, from rivers, or wells, soon change their colour, taste, and smell, and turn so fetid, that the seamen cannot drink them. The more impure they are, the sooner they putrify. *Thames-water* spoils in a few days; but, when it comes into the hot countries, it, again, purifies itself. Marshy waters, that contain the greatest quantity of oily particles, by standing on a fat earth, spoil soonest. This change in waters is owing to the different substances, that they have collected, from earth, air, vegetables, or animals, and from the invisible creatures that inhabit them. These undergo the general process, and impart to the water their smell and taste. But, being rendered volatile by it, they fly off; the earthy parts sink to the bottom; and the water is left as pure, nay more so, than it was at first. It
does

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does not appear, that the elemental particles of water are ever altered: therefore, the smaller quantity of foreign substances it contains, the less liable is it to putrify. The time that different waters take, before they submit to this change, gives a considerable insight into their nature. Mineral waters have never, yet, been considered in this point of light. Experiment, always, rewards its pupils.

1. ON the 10th of *June*, a bottle of *Dunse*-water was set in a south window, exposed to the sun and weather: but was scarcely altered on the fifth of *July*. The same water, well corked and sealed over, and placed in the room, was not altered in that time: but, after this last had been kept for six weeks, it had a nauseous smell and taste. That which was exposed, without the window, in bottles not corked, was no more altered than before; for the putrid particles flew off as they were formed.

2. THE

2. THE specific gravity of the corrupted mineral-water was the same with the vapid.

3. WITH the tincture of galls a deep *Burgundy* colour was formed. What was exposed, without a cork, suffered no alteration with the galls. This phenomenon surprised me not a little, when it was first discovered. That it should regain its steely spirit, after it was lost, would have met, unless seen, with little faith. I cannot, positively, say the precise time, that that spirit discovers itself; but it appears to be, with the beginning change to putrefaction.

THE reason of it, on the principles laid down, seems to be this. The intestine motion of the water, acts, powerfully, on its contents; renders them smaller; makes them volatile, and fit to mount into the air. The fixt iron, which we will afterwards discover in the water, is attenuated by this action; reduced into very minute particles; and so brought

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brought to a state of volatility. To confirm this reasoning, we observed that its smell, taste, and tincturing quality, went off in a very little time. Besides, on calcining the *residuum*, the magnet did not discover any iron particles. This is a sufficient proof of their being volatilized.

4. ON dropping spirit of nitre into it, no change happened.

5. No milkiness was observed with a solution of silver in spirit of nitre.

6. A SOLUTION of quicksilver produced a yellow cloud; a yellow sediment was soon precipitated.

7. SYRUP of violets was turned a little green.

8. THE bottles, when the water is poured out, have a gunpowder smell. A black powder is found sticking to the bottom. No
oker,

oker, or red pellicles are to be seen. The black substance is, probably, some part of the iron that cannot be rendered volatile.

9. To discover if there was any sulphur in the putrified water, as the smell seemed to indicate, a piece of silver was put in it for four days. It appeared, when taken out, to be a little dusky. From this, it seems, now, to contain a very small proportion of sulphur. Shall we conclude, then, because it is found in the putrified water, therefore it must exist in the water before corruption? The conclusion, my lord, would be too far strained: especially as this small quantity may arise from another source.

IRON, evidently, contains an inflammable principle. It is thus discovered. Iron, when ignited, or its powder dropt in the flame of a candle, sparkles: when corroded with the acid of vitriol, a sulphureous steam arises from it;

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it; and, if this steam be confined, by stopping the mouth of the bottle, till it is gathered in some quantity, and then, suddenly, unstopped at the flame of a candle, it will take fire, and make a noise, like the explosion of gun-powder. Whatever dissolves the iron, lets the inflammable principle escape. Putrefaction has this effect. There is, then, no cause of wonder, that the putrified water is found to alter the colour of silver a little; for the tinging of silver seems to be owing to the inflammable part of the sulphur. Charcoal and an alkaline salt, fused together over the fire, form a sulphureous substance that tinges silver black. This experiment shews, that the alteration of colour is made by the inflammable principle of the sulphur, and not by its acid. We are led, by this, to observe, what a small quantity of sulphur, will discover itself, by its effects, on silver: for there was no more, in a bottle of water, than what could escape from a half grain of fixt steel.

* Dr.

* Dr. *Shaw* just hints, "That he discovered
" a sulphur, in the putrified *Scarborough* wa-
" ter; but does not allow it to be a principle;
" and supposes it generated, as wine is, by
" fermentation."

10. THREE *English* pints of this water was evaporated, and gave three grains and a half of remainder. This, put on a red hot iron, did not emit any sulphureous smell. It contains, therefore, no fixt sulphur.

11. SOME of this *residuum* was calcined in the fire, but none of its particles were attracted by the magnet. Thus, we see, that the fixt steel is rendered so volatile, as to leave the water altogether.

PART

* P. 136. he gives a promise, in this place, of some experiments on the putrified *Scarborough* water; but, to our misfortune, never has done it.

PART II.

SECTION I.

IT may, perhaps, be doubted, my lord, whether chymistry has been of great advantage to the practice of medicine. This disadvantage has, certainly, attended it, that, for its preparations, simple medicines have been neglected; in which class most of our specifics have been found, and in which we are to hope for more. But its use, in the theory of physic, and in natural philosophy, can never be doubted. In the first it is very extensive. Many natural operations of the body are explained by it; the transmutation of victuals into our substance; the formation of chyle; of bile; of the salts; of the oils; of urine; and almost all the changes that happen in the human composition. It opens, likewise, to our view, the unnatural operations in our bodies, if I may call those of

L

diseases

diseases by that name. The noxious effects of putrid effluvia ; the consequences of stagnation in our fluids ; the progress of fevers ; and many other diseases are set, by it, in a clear light.

To natural philosophy it has been of very great advantage. The varied actions of bodies are now deduced from their constituent principles. Chymistry, properly managed, is the only science, that I know, capable of discovering these. There is no other, that can teach us to disjoin bodies ; mix them ; and observe the different effects that happen. There is no other that can transform *cold* bodies into *fire* ; *fixt* into *volatile* ; *fluid* into *solid*, and *solid* into *fluid* ; *mild* into *corrosive*, and *corrosive*, again, into *mild*. By these we understand the operations of nature. The metallurgic, the dying, and several other arts have reaped great advantage from it. How far farming and cookery might be reduced within its rules, and improved by it, would be

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be worth the consideration of some ingenious person. So far from being arrived at full perfection, chymistry seems, yet, scarcely, out of its cradle. The experiments, already made, bear no proportion to the various trials and various mixtures that might be made.

THE opinion of the first chymists, who imagined that salt, sulphur, and mercury, were the only constituent principles of all bodies, has been exploded, for near a century. The first * chymists knew nothing of natural philosophy, or its laws; and, what is worse, were, I doubt, scarce honest men. They endeavoured to impose on the world, and have been found guilty of falsehood. In their wild search, however, after the sovereign Elixir, that was to make man as eternal as his Maker; and the philosopher's stone, that, by changing every thing into gold, was to render him, almost, as powerful, many useful discoveries were made. The wild enthusiasm of the first cultivators of this science was,

perhaps,

* Basilus Valentinus, Paracelsus, Helmont.

perhaps, of more advantage to it, than the slow advances of more regular enquirers would have been. At last *Boyle* appeared, and placed chymistry on a rational footing.

THERE is a great objection against admitting the parts, that are separated, by the extreme heat of fire, as natural constituent parts of bodies: because they may, by its action, be generated, or produced from other principles. Nor do our modern chymists assert them to be natural. These are not, absolutely, however, to be rejected: for nature, we find, produces principles like those which arise from fire. Alkaline salts are discovered in the *German* waters. Their title to be esteemed natural, is as good as that of the mineral acids; since the first is found unmixed, the last always attached to bodies. But there lyes no objection against admitting these parts, as constituent principles, which are separated by a heat no greater than that of a summer sun. There is no necessity of ever
using

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using a greater degree in the analysis of mineral waters.

THE first part of this letter, my lord, was taken up in examining *Dunse*-water by additions of different materials. But this proof is not so certain, nor convincing, as the exposing of those very principles to the eye. This is the business of *Analysis*. By the former set of experiments, we had a great probability, that this Spaw is a compound of air, water, salt, earth, and a chalybeat principle: if we can separate these parts, so as to expose them to the eye and examination, we shall have a complete evidence of their reality.

I. ONE pound *English* weight, which is thirteen ounces and a half apothecary, was, at the well, put into a retort, and set in a gentle sand heat, with a receiver luted to it. The water was scarcely hot, when something came thro' the luting, and expanded it so, that it obliged me to make it fast with brown paper. What was in the retort, soon, turned
ed

ed of a light reddish colour ; and a red filmy substance like a spider's web rolled together, fell to the bottom. After all had come over into the receiver, that would, with this gentle heat, I found, in it, thirteen ounces and two drachms of water ; and, in the retort, one grain and a half of *residuum*. Thus almost two drachms had escaped.

2. To find out what it was that went off so soon, the beginning of the same process was, again, repeated. After this subtile matter had passed thro' the luting, and a very small quantity of water had come over into the receiver, I separated the glasses, and tried the water in the retort and receiver with the tincture of galls, but no change of colour happened. So that this subtile matter appears to have been the chalybeat spirit, with some air and water.

3. Two pound *English*, or twenty seven ounces apothecary, was evaporated, in a sand heat, not exceeding the warmth of the sun,

It

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It turned, in a little time, of a straw colour, and deposited reddish floating pellicles, that touched the bottom, but did not ly on it. After all the water was evaporated, the *residuum* weighed two grains and three fourths of a grain.

5. THE colour of the *residuum* is like high-coloured snuff. It feels gritty betwixt the teeth. A very nice taste can discover something saltish in it. It appears, in the microscope to be an opaque body, intermixed with diaphanous particles; these, probably, were salt.

5. THE *residuum* I put into the glass again, and set it in a pretty strong sand heat. It, soon, separated into two different substances; and these took two different posts. A grey earthy part lay at the bottom. About two inches up the sides of the glass and round it, there was a whitish circle, that stuck fast. It tasted saline and like sea salt. The powder on the bottom seemed earth.

6. THIS

6. THIS saline circle was dissolved in distilled water. Being evaporated, I found, at the bottom of the cup, one grain of a substance that looked like fine earth, yet tasted somewhat saltish, and above it a circle of reddish salt, that weighed about half a grain, and was the sixth part of the whole.

7. To discover if there was any fixt steel in the *residuum*, I sublimed it with Ammoniac salt. The flowers after sublimation appeared of various colours, but mostly blackish, as the martial flowers do; and had a very stiptic taste. Spirit of wine, in three days, drew no martial tincture from them. Galls had no effect on this tincture: nor the loadstone on its *residuum*. No conclusion can be drawn from this experiment.

8. SOME of the *residuum* was calcined in a strong fire. It had, after calcination, an iron colour; and, by the magnet, shewed great plenty of iron particles, which it did not before ignition.

9. To

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9. To discover the proportion of fixt steel in the calcined *residuum*, I dissolved three grains of it in water, and poured it off, when the first and heaviest parts had just fallen to the bottom, but before the light earthy could arrive there. This was repeated till the water came off clear. The remainder was attracted, wholly, by the loadstone; and weighed one grain and three fourths. These three grains were seven before calcination. Thus, about the fourth part of the *residuum* appears to be fixt steel. As some of the earth might have been attracted along with the steel, the following experiment was tried to make the affair more certain.

10. Fifty five grains of calcined *residuum*, that made, before calcination, two drachms and twenty four grains, was put into a reverberatory furnace, with an equal quantity of common flux and charcoal powder. After it had sustained the strongest fire for half an hour the crucible was taken out; but no iron was found fused at the bottom of the crucible,

cible, nor did the magnet attract any particles from it. In this experiment the iron seems either to have passed thro' the pores of the crucible, by the extreme heat of the fire, or to have been perhaps destroyed by too great a quantity of the common flux.

THAT we might discover, whether there was any * fixt sulphur,

11. THE *residuum* was rubbed, for some time, on silver, but no blackness was produced.

12. SOME

* MONSIEUR CHROUET discovered a sulphur in the residuum of the Spaw-waters. From 100 pound of the Geronster, he got a half ounce of glutinous earth, that was fat on the fingers, detonated with saltpetre, and emitted a suffocating vapour like sulphur.

THE residuum of 100 pound of the Pohon gave an ounce of sulphureous matter.

FROM the residuum of 100 pound of Tonnilet he got two drachms and a half of red salt, that would not dry for being unctuous: it detonated with saltpetre like common sulphur.

FROM the residuum of a like quantity of the Saurveniere, no mention is made by him of any sulphureous body.

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12. SOME of it was put on a red hot iron: It sparkled, like snuff thrown in the fire, but did not emit blue, or sulphureous flames.

13. A DRACHM of oil of tartar *p. d.* was mixed with sixteen grains of it, and put over the fire. This was infused, afterwards, in spirit of wine, for four days. The tincture never turned red; nor did any milkiness or precipitation happen, on a mixture of spirit of nitre.

THUS, we have been in search of a volatile and fixt sulphur, by all the experiments that are said to discover it: but in vain. Shall I therefore deny that there is a sulphur in it? no, my lord: the conclusion would be too strong. I can say no more, than that these experiments have not been able to discover any. I should look, however, on any person, asserting its existence, without a proof by experiment, as very opposite to the character of a candid enquirer into truth.

As

As to the smell and taste of sulphur, which some find in this water, I must observe, that these senses are very deceitful. The *German-waters* tasting acid and sharp, when they are just the opposite, is a signal proof that inferences, drawn from the senses, are fallacious, when trusted to alone. Many bodies, we know, that contain no sulphur, have this smell. Sea-water, when putrid, smells like rotten eggs. And how do we know but steel, or any other matter may be so modelled, as to produce the same effect on the senses?

SULPHUR has two very different and opposite smells. When burnt, it sends out a suffocating vapour, that is very uneasy to respiration: this proceeds from its acid; and is not what we have to do with at present. The other is, when it is joined and opened by an alkaline salt; then it has a peculiar smell, something like rotten eggs. This is owing to its oily part, after the acid has been attracted

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tracted by the alkaline salt: hence arises the smell of gunpowder when burnt, the alkaline salt in the nitre operating, in this manner, on the acid of the sulphur. It is this fœtor that is supposed to be in *Dunse-spaw*. But as no alkaline salt is discovered in it, this smell, if any such it has, arises from the inflammable part of the iron itself. How little will do this, the subtile effluvia of bodies, that, for years, send their odorous particles a great way round, without any loss of substance worth mentioning, evidently demonstrate. But this little, that escapes, perhaps, from the subtilized iron, can, in no shape, merit the title of a principal, or constituent part.

WHETHER there is any other subtile matter of an ethereal kind, or unknown steams raised by central fire, joined to this water, may admit of a question; but it is not so easy to come to a conclusion with regard to it. What escapes experiment, has not escaped theory. But, as we are sure of nothing without

out the first, we shall never admit any thing on the credit of the last alone. The analysis, that we have pursued in this section, has discovered, to the eye, air, water, salt, earth, and steel to be the principles that go to the composition of this mineral spring. Each of these deserves our consideration in particular.

S E C T. II.

THE different methods, that discover air in mineral waters, and which I pursued in the examination of this, are these:

I. WHEN water is taken, from the well, in a glass, we are to observe whether any air-bubbles mount from the bottom to the surface, and so escape. A few of these are to be seen in *Dunse*-water. In the *German*-waters, especially those of the higher *Germany*, these air-bubbles are in great quantity. A glass of *Selzer*-water, fresh from the well, seemed as brisk and sparkling, as a glass of *Champaign*;

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Champaign; and appeared, to the taste, so like it, that, had I not seen it taken from the fountain, I should have deemed it rather wine than water. This great quantity of air is, probably, the cause of that delicious cut-throat taste, as *Champaign* drinkers express it, in these waters. All fermented liquors, that have stood any time in bottles, contain much of this aerial principle, and produce the same sensation. Or, perhaps, what raises and begets the air, may cause the taste.

2. IF mineral-water, just taken from the well, is observed to be much lighter than the common sort, then it is, generally, thought to contain more air. *Dunse*-water is heavier. But this proof, for several reasons, is not to be depended on.

3. WHEN a quantity of the mineral water is put in a bottle with a long neck, if the water, after it has been kept for some time, is observed to subside, this is a sign, that a quantity

quantity of air was lodged between the aqueous particles, and kept them separate; but, after it has made its escape, they approach nearer, and the surface sinks. In this way *Dunse-water* discovers no air.

4. FREQUENT eruption, after drinking any fluid, discovers the aerial principle; for common water has no such effect on us. Nothing of this kind is felt on drinking *Dunse-water*.

5. LET a bottle be almost filled with mineral-water; shake it for some time; keeping the mouth of the bottle well stoppt. If there is much air in the water, it will rush out with a noise on unstopping the bottle. *Dunse-water* discovers very little air in this way.

6. LIQUIDS, that contain much air, often burst the bottles. But this water never does. The *German-waters* are allowed to stand,

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stand, for some time, uncorked, that the air may escape.

7. WHEN water, containing much air, is put over a fire, there is a great agitation and expansion from the rarefaction of the aerial particles. Thus, water that contains most air heats soonest. *Dunse*-water, put over a gentle fire, did not simmer.

8. THERE is not a better way to discover the quantity of air, than by the air-pump. When, by it, the pressure of the atmosphere is taken off, and the water eased of an incumbent load, the particles of inclosed air join, recover their properties, and escape in form of air-bubbles. In this way most of the fixt air is extracted, and becomes visible to the eye. *Dunse*-water discovers, by this experiment, more air, than common water does.

ON mixing *Rhenish* wine and sugar with the *German*-waters, an ebullition, immediately,

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ately, arises, and a great quantity of air flies off. Thus air is, indeed, produced, but, it seems, rather from the alkaline salts and acid of the *Rhenish*, than from the water itself. This experiment is, therefore, delusive.

ALL these experiments allow the air to escape; and, therefore, afford no just measure of its quantity. To attain this, we must catch the air, and exhibit it to the eye. An ingenious * gentleman, to whom the world is indebted for a train of experiments, has taught us a way to measure the quantity of air in all fluids. Following his method,

9. I PLACED an inverted bottle, full of this water, in a glass cistern, containing the same

* Dr. STEPHEN HALES. By this method he got from 54 cubic inches of well water, one cubic inch of air. From Bristol and Holt water the same. From Pymont twice as much. A good quantity from Spaw and Tunbridge. A great deal from bottled beer. From Ebsham and Aston little more than from common water. From Bath very little. Had he informed us of the precise heat and time, that these quantities were separated, we could have compared Dunse-water with them.

SECT. II. ON DUNSE-SPAW. 99

same water. The cistern was set in a kettle of water, heated to the degree of the human body. In half an hour, about the eighth of a cubical inch of air was generated and collected in the upper part of the bottle.

10. DR. *Shaw* gives us a method of catching the air, better fitted for our purpose, as we can handle and examine it in what shape we please. A bladder, well oiled on the outside, is to be tied very close to the neck of a bottle filled with the mineral water; care must be taken to admit no external air, and the sides of the bladder squeezed close together. As the air separates, the bladder is blown up. This experiment being made on a bottle of *Dunse*-water, exposed to a gentle heat, equal to that of the human, for an hour, the bladder contained about the eighth of a cubical inch. The same bottle was exposed to the atmosphere for nine days, and produced two cubical inches.

AIR,

AIR, collected from the water in this way, appears to be elastic, and capable of rarefaction and pressure, so far as I observed. It overcomes the whole force of the atmosphere by distending the bladder, and must be in equilibrium with it. It seemed to be of the same nature with our atmospherical air.

THE manner of its formation appears to be this. Steel contains a great quantity of this fluid in a fixt state, which makes its appearance on any dissolution, or separation of its parts. When it is dissolved by the mineral acids, a great quantity of air-bubbles, continually, escape. The same happens, tho' in a smaller degree, when the particles of steel are * separated by water. In this last way, a small portion of air, more than that of common water, is generated. I rather chuse to deduce its existence from fixt air, than from particles of iron, thrown off, and so becoming repellent air, tho' it is the opinion of some † great men. Air seems to be so general

* Vid. part 2. sect. 6. † Sir Isaac Newton, Halcs.

SECT. II. ON DUNSE-SPAW. 101

neral an element, so useful, with qualities so uniform and certain, that 'tis probable it was created, in the beginning, a body distinct from all others; tho' capable of change, yet always ready to return to its old form,

* *Nihil antiqua lege solutum*
Linqvit propriæ stationis opus.

GREAT feats, I observe, are expected from the oscillatory motion of this air, so plentifully contained in some waters, after it has entered the vessels. The effects of this are deduced from the effects of common air. † Authors say, that it enters the fine vessels, opens obstructions, and cleanses all the canals of the body. I should, hardly, my lord, differ from them, or doubt of these effects, were I not backed by all the writers on natural philosophy. From them we learn, that air, fixt in bodies, 'loses its elasticity, and is no more

* Boethius, lib. 1. metr. 5. † Hoffman, when he assigns effects to the aerial ethereal principle, seems, evidently, indeed, to mean the spirit. *De element. aq. miner. examinandis*, parag. 14.

more a real active element. Such is the situation of that in our fluids; which, not being elastic, can have no oscillatory motion, or expansive force. If it had, the effects would be terrible. For the expansion of air, from the freezing point, only, to the heat of summer, is in the proportion of six to seven. As our bodies contain more air than an equal quantity of the atmosphere, and the winter cold is often far beyond the freezing point, we would be torn to pieces, if the air, mixed with our fluids, still enjoyed the power of expansion. Besides, we find, that air, injected into the vessels, proves certain death.

11. To put this question beyond all doubt by experiment, I caught some blood in the small gut of a fowl, as it flowed from a vein, taking care to admit no external air. The gut being closely tied, was put in a glass, from which the air was, immediately, extracted. But the gut, full of blood, did not swell after the pressure of the external air was taken off.

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off. This shews, that the air contained in the blood was not rarefiable or elastic.

IT appears, that air never acts as air in the human vessels; and, therefore, as to these effects, it matters not, whether mineral waters contain much, or little of it. Shall I, then, deny the fixt air any power over our frame? no, my lord: but till that is once ascertained, 'tis impossible to say, whether a greater quantity of it, than usual, in the blood, will do good, or harm. It may, perhaps, assist the animalization, or tendency of our fluids to putrefaction: but as this is uncertain, and the common quantity of air serves very well the common purposes of life, I must doubt of any advantage a greater share of it would be to the human frame.

BUT the effects of too much air, in the first passages, is but too plain. There it produces eructations, pains, swellings, spasms, convulsions, as the history of those mineral waters, that contain much of it, show. To
prevent

prevent these effects, hot carminative medicines are taken along with them. Is this then a principle to be wished for in great abundance? by no means. As this ingredient can be of no service in the habit of the body, and can do much harm in the stomach and intestines, *Dunse-water* is, certainly, so much the better, the less it contains of it. As a proof of this, I know no such effects happen on drinking it, tho' no preventives are used, as, frequently, do in a course of the *German waters*.

S E C T. III.

THIS fair and varying scene 'of nature is upheld by change; and change is effected by motion. Were all bodies fixt, it would require great force to make their component parts alter their situation; and they would retain, for ever, the same unvaried force, unless exposed to the violence of attrition. A fluid body, therefore, that moved with ease itself, and would be the cause of motion in others,

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others, was absolutely necessary, in the structure of this globe ; for it was designed to be comely and useful to its inhabitants. Water answers this purpose. It divides, imbibes, transports the solid parts ; and, by applying them elsewhere, is the cause of increase and vegetation. It is no less necessary to putrefaction, the other great change in nature ; which, without this element, can never go on. The life of animals and circulation of their juices depend on it. The greatest part, both of vegetable and animal substances, is found to consist of pure water. The mineral kingdom owes, perhaps, in some measure, its stability to the want of this principle. So general and useful a part of the works of nature demands our consideration.

WHAT was separated by distillation from the *Dunse*-water seemed to be pure elemental water. A solution of silver in spirit of nitre made no alteration in it. Nor did galls. The colour of silver was not altered by lying ma-

O

ny

ny days in it. Nothing impure or * heterogeneous appeared, on trial, mixed with it.

ONE of our greatest modern † physicians asserts, That the good effects of mineral waters depend, not on their ingredients, but on the elemental water. As a proof of this, he informs us that several wells in *Germany*, of very great fame, contain no mineral particles, but draw their virtues from a pure light water alone. Of this kind are the *Toplicenses*, *Schlanginbadenses* of *Hesse*, *Friginwalgenses*, and others. These can boast of nothing chalybeat, earthy, or saline, and yet have great virtues, used internally, or externally. They are lighter than rain water, and leave no sediment on evaporation. Altho' this conclusion is pushed rather too far, yet it cannot be denied that much depends on the
purity

* MINERAL waters distilled have discovered their qualities. Mons. Chrouet says, That what was distilled from the Geronster a second time was bitter, and had a sulphureous smell; what came from the Pohon was sharp, and had no smell of sulphur.

† HOFFMAN de therm. et acidul. usu et abusu, parag. 6.

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purity of the watry principle, and that it is of service, not only as a vehicle to the others, but as an active part.

WATER is allowed, by all the writers of natural philosophy, to be a very subtile body: even more so than air. It has penetrated the * pores of gold. It is probable, then, that there is no vascular part of the human body, how minute soever, which this constituent part cannot with ease pass through. We can with no justice refuse it a circulation through the nerves, if they are pervious, as they seem to be. It must be the most general circulating principle of our fluids, and serve as a vehicle to the rest. As its use is great, so its deficiency must be as greatly felt. When this happens in a particular place, then an obstruction is formed: but if the case be general

* To discover whether water could be compressed into narrower bounds, the Florentine society made a hollow globe of gold, filled it with water, and squeezed the sides together with the utmost force of machines. The water was not compressed, but forced thro' the pores of the gold, and appeared like dew on the surface.

neral with the whole fluids, as sometimes happens in inflammatory fevers, when their oiliness rejects the water, most horrid symptoms arise, and death treads fast at their heels.

OBSTRUCTIONS, under which name most diseases rank themselves, arise from the close attraction of the more solid parts, while the fluid are pressed out. Water seems well fitted to remove them. Its subtilty carries it every where; its dissolving power opens; its fluidity washes away; its blandness sheaths; while its continual secretion carries off all unnatural concretions. If obstructions can be opened by art, this seems to bid the fairest chance for being the instrument. All these good effects we are to expect from this principle of *Dunse*-water, which is very soft, and, after the precipitation of the mineral parts, light as the purest rain water. I imagined that its passage thro' the marly bed might give it that softness, and found, by experiments, that water, hardened by a solution of
sea

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sea salt, was made more soft and less salt by a mixture of marly earth.

As the neighbouring fountain always supplies your lordship's own cup, it will not be disagreeable, I suppose, to be informed, what are the criterions of good water; what the properties of its different kinds; and in what manner they may be best mended when bad: a speculation very useful to mankind, but more particularly to one of your lordship's temperance. *Hippocrates* thought this subject not unworthy his consideration, and has left us a few good observations on the effects of different waters. * Some of great character among the moderns have attempted this subject.

Good water is known by the following properties:

It has neither colour, taste, nor smell; for these discover a mixture of other bodies.

It

* Boerhaave, Hoffman.

IT is light. This appears by its quick heating and cooling: but more certainly by the hydrostatical balance. The hydrometer, with a long neck, divided into different degrees, to mark its different depths, answers very well the purposes of common life. The lightness and gravity of common water, I find, depends not on the quantity of air contained in them, but on a mixture of earth and sea salt, which are found more or less in almost all. On mixing both these materials with water, I found it specifically heavier.

IT must be light on the stomach by a quick and easy passage out of it. This levity is very different from the former; for water heavy in the balance may be very light in the stomach. This seems to depend on great purity, or, perhaps, a spirituous principle. The sensation is our only test of this quality.

THE longer water remains in an uncorrupted state, the better it must be. The progress of putrefaction is in proportion to its
vege-

SECT. III. ON DUNSE-SPAW. III

vegetable, or animal contents. Hence rivers, that wash great cities, and standing waters, are, of all others, the most liable to corruption.

To be soft is one of the chief properties in the offices of common life. The hardness of water, I find, depends mostly, if not entirely, on sea salt: for water, that easily dissolves soap, is hindered from doing it by a mixture of sea salt; even after soap is dissolved, the equal solution is curdled by an addition of that salt. As the same effect happens betwixt salt of tartar and sea salt, the curdling of soap must, still, be owing to the action of these two. From this we can easily account why hard water should be such a friend to the scurvy. The criterions of soft water are, that it brews well; boils pease without making them hard; dissolves soap equally; and washes dirt entirely out of linnen. We must take care, however, not to mistake a degree of putrefaction for softness, for we find water softens in its tendency to corruption.

tion. Hard water may agree best with some constitutions.

It should not turn turbid with a solution of silver in spirit of nitre; nor milky with oil of tartar *p. d.* or cloudy with a solution of sugar of lead in water. These changes discover a mixture of saline and terrestrial particles.

AGAIN. The smaller proportion of terrestrial particles it contains, so much the better. Water can never be got entirely free from them: not even rain water. Yet, there, they make but an inconsiderable part. Several springs approach near it. This purity is known from its leaving no † incrustations on the sides and bottoms of kettles that have been in long use. But the most certain method, to discover the proportion of pure element to the solid part, is evaporation:

† HALEs tell us that there is a spring in the palace-yard of Hampton-court, that left no ~~stone~~^{one} concretions on a kettle, in which it had been boiled, without cleaning for fourteen years.

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on : by that the whole is made visible and capable of weight. The nearer it approaches to rain water, so much the better.

THESE, my lord, are the signs of good water ; and, thus, every one, who is as much concerned as your lordship, can, with ease, discover, whether that, which he uses, is so, or not. I have given no rules but what may be easily understood, and as easily applied. It is to be regretted, that we have not a natural history, on this scheme, of all the waters, whether well, fountain, or river, in every county; their defects might, in some measure, be corrected, and the inhabitants reap the benefit.

WATER in general is divided into these classes ; rain, fountain, well, river and lake. The character and properties of each is worth the inquiring into.

THE air contains every thing that can be made volatile by the sun, fire, subterraneous
P heat,

heat, putrefaction, fermentation, attrition, or effervescence. And, therefore, different salts, oils, spirits, earths and metals, too, are, continually, floating in the atmosphere. Rain, that ascended in form of vapour, floated in it, and again descends, must contain all these different bodies. As these effluvia alter, so must rain. It is very different, therefore, in different seasons; very different in drought from what it is in moist weather; very different after thunder from that which falls at any other time. This water at best is found impure; contains often the seeds of many plants; † when kept, changes into a thick mucilaginous body; and putrifies soon. It is, however, in general, better than most fountain water. It is very light, heats and cools soon, dissolves soap easily, and has scarcely any sediment, when it is gathered at a distance from any city; for the smoke of towns defiles it much. It is thought to be best in the east and south winds, and in the month

† BOERHAAVE found in it the seeds of the *Alga fluvialis*, and the *Fungi*.

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month of *May*, being then replete with the finest effluvia of the earth.

RAIN, having fallen on the earth, sinks a few feet, glides along the sandy stratum, towards the more depending places, till it finds an exit, and then appears, again, in springs. Hence they are most common in those valleys that are surrounded by hills. *Switzerland*, the highest country in *Europe*, gives rise to the greatest rivers in *France*, *Germany*, and *Italy*. Rain strained, thus, thro' sand, which is nothing else but a quantity of irregular flints, fitted to intercept all heterogeneous particles, must appear more pure, if it met with nothing dissolvable in the way. But it can scarcely miss of this: and therefore comes out more impure; sometimes medicated; nay even poisonous. It is, in general, heavier than rain water; contains sea-salt; and deposits *fæces*; especially, when boiled. Springs that come from calcareous ground, or rocks, are observed to be hard and bad: as are likewise those in the neighbourhood of
hot

hot wells. What passes thro' sand and gravel is the best, for from these it can take no tartarine qualities.

PIT well-water differs very little from fountain in origin, being strained thro' the same sandy stratum, which is commonly found ten or twelve feet below the surface. But as it does not run like springs, 'tis more impure. Rest gives it a degree of corruption, that fountains are strangers to. Well-water is always harder when low, than when full, from a greater quantity of sea-salt: and all-wise the regulation is! for, then, the water tends faster to corruption from the scanty supply.

RIVERS owe their origin mostly to springs; and must have their qualities. But as they are inhabited by fish; as they sweep the plains; as they receive the filth of great cities; as they are exposed to all animals; and as their subtiler parts are exhaled, they must be, considerably, more impure than the former. They differ, according to their circumstances,

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cumstances, from one another ; nay, often, from themselves. Such an odds there is in their specific gravity alone, that a bark, which can keep above water in the *Mayne*, will sink in the *Rhine*. So nothing can be said about them in general. They are commonly more impure; softer; lighter; and more inclinable to putrefaction, than fountain-water.

THE water of lakes, morasses, stagnating canals, ditches and bogs is supplied by springs and rain. These are replete with the impure slimy substances from the earth; the salts and oils of the acrid plants * that grow in them; whatever air can give, and winds can bring; or whatever fishes, or other animals leave behind. Thus, it is the most impure of all; and always prone to putrefaction, when favoured by the heat. Instead of containing insipid bland juices, it must

* THE plants, that grow in stagnating waters, are, generally, of a sharp nature, and some of them even caustic. As the *Acorus*, *Arum*, *Aconitum*, *Cicuta aquatica*, *Nasturtium aquaticum*, *Perficaria acris*.

must be full of acrid and volatile. Hence the country around is always unhealthful, from these volatile parts flying off; and is visited, in great heats, with epidemic and pestilential diseases. These are the unfittest of all for use. They are the most acrid, most impure, and most ponderous of all waters.

As in many places, especially the low and flat counties, no good water can be found; it may be of benefit to their inhabitants to learn the art of rendering them pleasant and healthful. The chymical methods of distillation and precipitation can never be brought into common life. I shall only mention what is in every one's power, and may be followed at almost no expence.

FROM these observations it appears, that the impurity of water arises, either from a degree of putrefaction, or too great a proportion of saline and terrestrial particles. The first is the case of all stagnating pools, or wa-
ter

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ter kept too long; the last, of rivers and springs. When corruption once begins, which is known from its bad smell and taste, the water must be freed from these volatile acrid particles, e'er it can be used. If necessity requires an immediate remedy, they must be dispelled by boiling. The heat and agitation of the water sends off these noxious parts; and the terrestrial, being freed from the volatile, that suspended them, sink to the bottom, after the boiling is over. Where no volatile salts, or oils are to be dispelled, the action of the fire rather hurts water, by robbing it of the most active particles.

NATURE, when the progress of corruption is not stopped, frees herself from these noxious parts, by rendering them so volatile, that, without any assistance, they fly off. By imitating her, we shall arrive at the same end. Let, therefore, the putrefaction be encouraged by closeness, heat, and great vessels. In time it becomes fit for use; and is, then, thought to be as pure as distilled water. This
practice

practice is said to be common in *Rome* with the *Tyber*-water. This always happens in long voyages: and this is the only way to procure good distilled water from the sea.

WHEN the saline, or terrestrial parts prevail too much, so as to render it hard and heavy, they must be separated. *Transcolation* is the surest way to obtain this end. The *Sicilians* purify their water by passing it thro' a stone called a filtre. Sand is the fittest body for this purpose. It communicates nothing; and so effectually stops every heterogeneous body, that sea salt, and all earthy particles, are detained by it. A well dug in the shore often affords fresh water. The *Austrian* army, when encamped in *Hungary*, find no good water, unless when on the banks of some great river. When they are obliged to use lake-water, they purify it in this manner. A long small boat is divided into several different apartments by cross partitions. They fill them all, except the last, with sand. The boat is put in the lake. A
hole

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hole level with the surface of the water is made in the end of the boat, which lets the water into the first division. From this it gets into the second by a hole made in the bottom of the first partition. From the second it runs into the third thro' a hole in the top of the second partition; and so, alternately, above and below, that it may be obliged to pass thro' all the sand. At the top of the last division there is a pipe, thro' which the water comes, at pleasure, as pure as from a fine spring. Thus all bad effects are prevented.

WHERE the water is bad, I would propose some such scheme to be followed in every house. Some casks, divided in the middle, and filled with sand, would serve the purpose very well. Into the first of these divisions the water might be thrown as into a cistern. The casks behaved to be joined by pipes. By making it circulate thus thro' eight or ten divisions, filled with sand to the

Q

top,

top, a pure spring may be had any where ; and a marshy flat country vye, in good water, with the inhabitants of the vallies.

S E C T. IV.

LEST the general tendency of bodies to putrefaction should go on too fast, and nature herself, at last, dissolve in corruption, it was necessary there should be some bar to its progress. Sea salt was, therefore, mixed with almost all matter. Its quantity is discovered to be in proportion * to the force of its antagonist. All waters, whether spring, well, or river, have a share of it, and show how universal this principle is over all the earth.

WE have, already, discovered a salt in the *residuum* of the *Dunse*-water, and found it to be about the sixth part of the whole. The follow-

* TOWARDS the north, and especially in the Baltick, a pound of sea water contains but two drachms of salt. In our seas the same quantity has twice as much ; and about the Spanish coast it affords an ounce. This must arise from more salt-pits in the southern, than northern latitudes.

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following experiments were tried to ascertain its nature.

1. THIRTY two pound of water was evaporated, and the *residuum* dissolved in rain water filtrated, and set on a gentle fire. When there was about six ounces, it had a saltish taste like a solution of sea salt. When it was near evaporated, I set it to crystalize; and got two grains of crystals. The remaining liquor was salt and bitter, and would not crystalize. On evaporation twelve grains of a saltish powder was got, for the finest of the earth had passed, with the salt, thro' the brown paper. With a little heat the salt separated itself from the earthy part, in the form of a circle, an inch from the bottom. It weighed six grains.

2. THE crystals tasted just like sea salt, and were of a cubical figure.

3. THEY decrepitated and crackled when put on a red hot iron.

4. THE

4. THE salt got by evaporation, when dissolved in water, made no change on syrup of violets. Nor was altered with distilled vinegar. Raised a little motion with spirit of vitriol; which might be owing to some of the earth still adhering to it. Appeared milky with a solution of silver.

5. WHEN oil of vitriol was poured on it, the same white vapour and pungent smell arose, as from an equal quantity of sea salt, mixed with the same acid.

THESE characteristical properties appertain only to sea salt, and shewed it evidently to belong to that class. Nor was there any occasion to search in it, for the other effects of that salt; such as dissolving in six times its weight of water; proving a menstruum for gold; assisting in the formation of steel: affording the spirit of sea salt: melting with difficulty over the fire, and passing, at length, thro' the crucible. Its small degree of volatility is seldom mentioned among these properties,

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perties, tho' I find it rises an inch or two along the sides of the glass.

It is observed by chymists, that there is a certain portion of this salt, which will not crystalize, and remains behind a bitter salt liquor. This part is called the Bittern; and appears to be very distinct from the former. It consists of the acid of vitriol, and an alkaline earth: for the former is, easily, attracted from the latter by an addition of a fixt alkaline salt. Most of the salt in *Dunse-water* seems to be of this sort.

As the proportion of it is less here, than in common water, it scarcely merited our attention as a principle, if not to fix its species, and shun all imputation of inaccuracy. The quantity is but small, in proportion to what we, daily, take with our victuals. Its universal use demands a scrutiny into its nature and effects.

It

It is got from pits, fountains, or the sea. All these seem to be the same at bottom; and differ only as they are differently mixed with sulphureous, oily, earthy, or calcareous particles. What is most depurate is the best. Rock salt appears to grow in the pits. It seems to be formed by a conjunction of an acid and mineral alkali; the last is, probably, of the same nature with that found in the *German* mineral waters.

Its effects on the human body are more the subject of observation, and admit of greater certainty. The grateful taste it gives to things, otherwise insipid, is the cause of its universal use, and the method nature takes to force it on us. It cleans the palate; gently stimulates the nerves; and renders them of delicate sensation to other things; while itself is most grateful to the taste. By gently vellicating the coats of the stomach, its motion is quickened, and the secretion of its fluids is augmented: hence digestion is promoted. It has been alledged, that people will
not

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not fatten without it. The inhabitants of *Greenland, Lapland* and *Nova Zembla*, where salt, on account of scarcity, is not used, are observed to be of low stature, weak, and unfit for fatigue: whereas those of *Finland*, where salt is in plenty, are robust, laborious, and warlike.

AFTER it has got into the habit, it assists, by its stimulating power, all the natural secretions of the body; and, so, helps to carry off those particles, that are unfit to circulate. Those that work in the pits are healthful. It has been observed that people, who use little salt, are oftner troubled with diseases, than they who take it moderately.

BUT its chief use in life is owing to the power it has of resisting putrefaction. The benefit that arises from this property is great. The human body is continually tending to corruption; and would, perhaps, go on too fast, especially in the young, the active, and inflammatory, were it not retarded by a mixture

ture of this with our victuals. Our bodies are, thus, kept continually salted. What was to withstand corruption must needs be incorruptible itself. There are few substances equal to it in this respect. Dissolve it in fluids, it is still recovered again intire. It escapes, unaltered, from the human body. The process of putrefaction, that changes other salts, has no effect on this. Nothing in short but the extreme violence of the fire can make an impression on it. If this body grows, while it is scarce capable of change, the sum total must be in continual increase. Hence the sea must advance in saltness, from the addition of fresh particles brought to it by the rivers, while none can get out.

S E C T. V.

TO give this globe a firmness and stability, an earthy substance was necessary. Fire, water, air, salts, and oils, were either liquid, or easily dissolvable in liquids; and so unfit to bear the weight of animals. A terrestrial principle, then, was made the basis of the

SECT. V. ON DUNSE-SPAW. 129

the whole, with different degrees of cohesion, and scarce dissolvable in water.

* *Sic igitur terræ concreto corpore pondus
Constitit.*

THIS is the principle that gives solidity to the vegetable, the animal, and, perhaps, to the mineral kingdom. It is, always, discovered in the two first; and, often, in the last. Salts † and oils ‡ seem to become volatile when freed from it. Yet how small a quantity serves these purposes! for the proportion of earth in bodies is but very inconsiderable.

WHETHER all earths be, ultimately, the same, and the difference only depending on
R the

* LUCRETIVS, lib. 5.

† PUTREFACTION seems to render the salts and oils volatile, by separating them from the earthy part; for every thing flies off except that.

‡ THE softer oils are distilled, the purer and more volatile they become; for they leave much earth behind them every time. When salts are impure from a mixture of oil, chymists mix earth with them. By this means the oils are fixed, and the salts ascend more pure.

the different arrangement of similar component particles, and the various mixture of other elements, would, perhaps, be too subtle a scrutiny. There is great reason to think so: for the virgin earth, extracted, by chymists, from vegetable and animal substances, is the same. Yet, in a general way of speaking, the word varies much, and different professions attach different ideas to it. The farmer has quite a different notion of earth from the chymist, and the chymist from the examiner of mineral waters.

By the last, every thing that remains indissoluble, after the salts have been extracted from the *residuum*, is called Earth. But as this name is too general, and takes in, not only earthy substances, but mineral and sulphureous likewise, they have confined it to certain kinds, that have been observed in mineral waters.

OKERY earth, according to them, has a yellow, or red colour: a rough astringent taste: and yields iron on fusion.

CALCA-

SECT. V. ON DUNSE-SPAW. 131

CALCAREOUS earth dissolves easily in the mouth: effervesces with acids: turns corrosive, like lime, by fire. These qualities quadrate exactly with one sort of marl; and, therefore, this earth is not accurately defined.

STONY earths are known by falling immediately to the ground like sand. By turning into glass with a fixt alkali.

THE marly earth is another mentioned by writers; but in such general terms, and so inaccurately, that its properties are not to be learned from them. 'Tis impossible, as there are different kinds of marl, to give a description that will suit every sort. Therefore, as it is much used; as its properties are unknown; nay the very names of its different kinds unheard, where it is not found; and as the subject, so far as I know, lyes yet untouched: an attempt to discover its qualities and composition cannot be disagreeable to one, who is so great an improver as your lordship. We are, naturally, led to it by our
subject,

subject, as the earthy part of *Dunse*-water is of the marly kind, and the bank near the well is full of it.

IF marl dissolves easily in water, and discovers little, or no sand, betwixt the teeth, or fingers, it is, then, thought good. These are the only ways it is tried before it is made use of: but they are too inaccurate to fix a certain judgment of its goodness. This must arise from the strength of its properties, discovered by the following experiments:

THERE are three different kinds, *clay*, *slate* and *shell Marl*. The clay marl, when hard, crumbles down easily betwixt the fingers; and dissolves in the mouth. It has, commonly, some shining particles in it. There are various colours of it.

SLATE marl separates into *laminæ* like slate; dissolves easily in the mouth; and has a fattish taste like chocolate. When good,
it

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it has not the least grittiness. That used in these experiments was extremely good, but very hard.

THE shell marl is commonly found in boggy ground, about a foot below the surface. It has an odorous smell, and dissolves in the mouth with a little grittiness. There are a vast number of small white shells, some entire, some broken, to be seen in it, with straws and other dirt. By the microscope it appears an open, cotton-like body, full of white shells. This kind has the least cohesion and specific gravity.

1. To discover the time and force of solution in water, three ounces of this was added to nine drachms of each kind. In a few minutes the clay marl cracked, and fell down in pieces: the slate marl bursted, and separated itself into *laminæ*: but the shell still kept its form, tho', now, become very soft. With a tea-spoon I used a little force to break them down: the shell marl easily yielded to it;

it; the clay marl more difficultly; but the slate marl was too hard to be divided with this small force. The shell marl was, now, swelled to a size, much greater than the others; and had sucked up all the water; while these had imbibed but little. Thus, it seems to have the strongest imbibing, dissolving, and expansive force, while the other two, compared to it, are but weak in these respects. The clay seems to dissolve easier than the slate marl.

2. I TRIED them next with different acids, that of vinegar, spirit of vitriol, and spirit of nitre. With them all there was a strong ebullition and effervescence. But the shell marl required six times more acid to saturate it, than the other kinds; and effervesced with a greater vehemence. A drachm of clay marl attracted forty gutts of spirit of nitre: as much slate marl took twenty eight: but the shell marl required two hundred and forty.

3. WHEN

SECT. V. ON DUNSE-SPAW. 135

3. WHEN the acid of vitriol was joined to the clay marl, I perceived a sulphureous smell. This I thought proceeded from the iron it contained; but galls made no change.

4. To discover if they contained any salt, I dissolved them in water, filtrated, and evaporated it. A very inconsiderable portion, of a brownish substance, was got from shell marl, that had a bitterish and somewhat saltish taste. Still a smaller quantity of this was got from the other two sorts. They do not contain, then, any salt; at least, of a perfect kind. That bitterish substance was possibly generated by the action of the air, as they had been kept for some time.

5. I ENDEAVOURED to separate these marls into different parts, by distillation in close vessels.

FOURTEEN drachms of clay marl gave a drachm and a half of water, and twelve of *residuum*, so that half a drachm, perhaps, of
water

water or air, had escaped thro' the luting. The distilled water had a marly taste; was very soft; turned a little green with syrup of violets; but did not effervesce with spirit of vitriol.

SLATE marl, treated the same way, gave the same water, but in smaller proportion. Thus it contains no oil, tho' the taste would incline me to think it did.

ON opening the glasses, in which the shell marl was distilled, a volatile pungent smell, like that of spirit of hartshorn, issued out. The neck of the retort was covered with a thick empyreumatic oil, too heavy to rise further. In the receiver was a volatile alkaline spirit, with some thick fetid oil on the top. Shell marl, then, appears to be an animal substance; and, like it, contains earth, water, two oils, and a salt capable, by fire, of turning alkaline and volatile. It is, therefore, very different from the two former.

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6. I TRIED next what alterations an open strong fire would make in these bodies.

A DRACHM of clay marl calcined, for an hour, in the strongest heat of a smith's forge, lost ten grains, and was of a light snuff colour. It was no longer dissolvable in the mouth, in water, or vinegar. The magnet discovered iron in it.

THE same quantity of slate marl, calcined the same time, lost eighteen grains. It was of a dark red colour; nor would it dissolve in water, or vinegar. The loadstone discovered in it a great quantity of iron.

THE same quantity of shell marl lost thirty two grains. Its colour was but little altered. It dissolved in the mouth with a sweetish taste like lime; effervesced with acids; attracted water, and gave it the same taste, that lime does. No iron was discovered in it. Hence appears another great difference betwixt these marls.

S

A GREAT

A GREAT many more trials might be made, but I trust these are sufficient for ascertaining their properties, nature and composition. Whether the difference, in these experiments, betwixt the clay and slate marl, arises from a difference of substance, or cohesion, matters not. It is enough that they are found different.

LET us now see to what species of these the earthy part of *Dunse*-water belongs. It was of a light colour: effervesced with acids, and destroyed their acidity: turned red on calcination, and was no longer dissolvable in water. Thus, it appears to belong to the clay, or slate marl: more probably to the last.

THE effects of this earth, on the human body, must be to absorb and destroy all acidity in the stomach and intestines, and to turn it into something neutral and innocent. I scarcely believe its operation will go much further: tho' that, indeed, is no despicable effect, as gripes, cholic, purging, are oft-
en

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en owing to the prevalence of acidity. It seems in no shape inferior to crabs-eyes, or any other sweetner; for that is the name absorbents generally get.

How these marls are used in agriculture, your lordship is better able to instruct me. Some loose thoughts, on their manner of operation, and fertilizing ground, may not be disagreeable. 'Tis a speculation worthy of attention: and, once established, may afford the improver several hints in the application of this excellent manure. It will serve as a specimen of the junction, hinted above, betwixt chymistry and the farming art; and show, that the plan is not quite so chimerical, as it appeared, perhaps, at first sight.

THE operations of all bodies are to be drawn from their known qualities and properties, ascertained by experiment. Reasoning, on any other footing, is chimerical and delusive. The most remarkable, then, if not the only, properties in marl are, its swelling and

and bursting with water ; and its power of attracting acids. On these two qualities we must proceed, if we have a mind to travel on sure ground.

IF therefore the soil be too adhesive and stiff, as farmers call it, marl must swell, loosen, burst, attenuate, and open the glebe, when once the moisture has acted on it. The roots of plants will, then, push themselves down easier and further, and so draw nourishment from a greater distance. This effect, as it is wrought in a mechanical way, I chuse to call its *mechanical power*.

7. To make it obvious to the naked sense, equal quantities of the different kinds of marl were mixed with equal quantities of stiff clay ; formed into separate balls with water ; and dry'd before the fire. A ball equal to the former was formed of pure clay. These, when dried, were put into water that covered but one half of them. The two balls made of clay, and slate marl with clay, fell down

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down in powder, by degrees, to the bottom. The ball made of shell marl and clay swelled, cracked, and attracted the water over the half that was above its surface. It turned soft, but did not fall down in powder. The ball of pure clay was not in the least affected. This experiment brings home to the eye the mechanical effect of marl, and shews its strong attenuating power, when mixed with a stiff clay. It has been used on such ground with great success. I am not ignorant, that it has a quite contrary effect on light ground; or is thought to have. It may well be so. As marl has a certain degree of cohesion, it will bring all ground, that has less than itself, to its own firmness, and render very light ground more stiff.

THE *Roman* poet and farmer, when speaking of opening ground and fitting it for the roots of young trees, gives this advice;

* *Aut lapidem bibulum, aut squalentes infode
conchas.*

THIS

* VIRGIL, Georg. II. l. 347.

THIS description agrees so well with the different kinds of marl, and their effects, that I am almost led to think he speaks of them. Whether this criticism be just or not, your lordship is the best judge, as he seems your favourite poet.

BUT the great effects, that marl discovers in assisting vegetation, can never be owing, entirely, to this mechanical power. For how would it better ground, that is, already, of a due consistence? It must have another power independent of this: and this we must seek for in the other quality, that of attracting acids. If we examine the different composts, made use of to enrich land, we shall soon discover them to be of an alkaline nature. All animal and vegetable substances putrified, dung, soot, are volatile alkalines. The ashes of wood contain a fixt alkaline salt. Lime and chalk are of that nature. All these effervesce with acids. In this alone they all agree; while in other circumstances they differ widely. On this alone their vegetating

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getating power must then depend. Here marl agrees with these; and, from hence, derives its *fructifying power*. For so I would call this last, to distinguish it from the mechanical.

MARL and these other manures operate, I imagine, in this manner. The atmosphere most certainly contains an acid. Alkaline salts, exposed for a time, turn neutral; which can only be effectuated by receiving an acid from the air. Their affording, under these circumstances, an acid puts it beyond all doubt. The *caput mortuum* of vitriol or allum, generates new salts in the air. Lead in time turns to ceruss. But the formation of nitre is the most convincing proof of this acid. Whether this be of one kind *, as the chymists seem to think, by naming it the Vague acid, or of different sorts, I shall not pretend

* It appears to be the vitriolic acid. This acid seems capable of being changed into the marine or nitrous acid, according to the matrix to which it is joined.

pretend to determine. 'Tis enough for me, that experiment discovers it.

IF marl, then, is exposed to the atmosphere, it must, it will attract the acid; and turn into some neutral body. The same must happen to the other alkaline manures. This is the unknown principle that the glebe receives from the influence of the air; for all soils contain a proportion of alkaline particles. The quantity imbibed must be according to the exposition of fresh attractive matter. This observation every farmer has made, without knowing the cause. Experience teaches him, that the action of the plough makes his fields more fertile.

* *Ille seges demum votis respondit avari
Agricolæ, bis quæ solem, bis frigora sensit:
Illius immensæ ruperunt horrea messes.*

WERE it not a dangerous way of reasoning to argue from final causes, it might be easy to show, that nothing could counteract the

* VIRGIL, Georg. I. l. 47.

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the alkaline corrupted quality of putrefaction, and bring it to a wholesome neutral state, but the agency of an acid. But we need no uncertain proof, as experiment is our friend.

THE nature of that neutral substance, formed by marl, and the acid of the air, may be guessed at by the formation of nitre. This is manufactured in the *Indies*, by exposing alkaline bodies to the air; and is, therefore, very analogous to our present purpose. Putrified substances, old lime, and a sort of earth like our marl, are made use of to be changed, by the aerial acid, into a neutral salt, fit to become nitre, when treated in a certain way. Such, likewise, must be the product from marl and other composts. Could we discover such a salt from a junction of marl and acids, this theory would be greatly confirmed.

8. I SATURATED the different kinds of marl with the acid of vinegar. When they had stood some days, and were dry again, I
T found

found a saline substance, in great plenty, shooting up the sides of the cups. This salt was white, and tasted rough in the mouth. The same experiment was tried with the spirit of vitriol: but, with it, little salt was procured. Whether this was owing to the peculiar nature of the acid, or to the shortness of time it was allowed to stand, I know not.

9. To saturate marl with the spirit of nitre, into which the acid spirit of the air is probably changed by the matrix, seemed to come nearer the point. To a drachm of shell marl, as much spirit of nitre was added, as it would absorb. This was diluted with water; filtrated; and evaporated. From this I got forty five grains of a whitish salt, that had a bitter, pungent, nitrous taste. It was swelled up to a great degree. It would not crystallize, but agreed with nitre in almost all its properties. Brown paper dipt in a solution of it, and dried, was turned into a sparkling match, and burnt to the end. It preserved flesh, and turned it red. It deflagrated as
nitre

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nitre does, with the coal of burnt wood. I tried to bring it to crystallize, by an addition of salt of tartar; but I could not accomplish it. There seems to be a secret in the manufacture of nitre that we are not yet well acquainted with.

A SALT, that seemed of the same nature, was got, in this way, from clay and slate marl; but in much smaller quantity than from the former. Lime, saturated with the same acid, yielded it in great abundance. How far these experiments will be of use in other points; how far they determine the composition of salts; and discover the operations of nature; how far those, from different acids differ; or if those, from different manures and the same acid, agree; these questions, I say, merit consideration. But this is not the place. Our only intention, here, is, to find out the nature of that neutral substance, formed by the marl and acid of the air. This appears, even to the senses, to be a salt of the nitrous kind.

IF there is any acid in the ground that renders it unfruitful, as the vitriolic acid is thought to do, the marl will attract it, and convert it, from a noxious, into a neutral fruitful principle. The effects here must be the same as in the former case.

THIS theory, if just, should account for the different operations of these different marls. The shell marl produces as good crops the first year, after it is laid on, as it does in any of the subsequent. The clay marl has not its strongest effect generally till the third year. Slate marl is still more slow in its operation : some out of the same pit, that I had mine, lay on the ground undissolved for four years, without enriching it in the least. The formation of the nitrous salt, that seeming cause of vegetation, must depend on, and be in proportion to their power of attracting acids, and small degree of cohesion, by which a greater number of particles are in action. The shell marl we found to be the most soluble in water, and to attract acids with the greatest

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greatest force; the clay marl came next; and last of all the slate. They must, then, form themselves into that nitrous salt, and have their effects in the same course, as experience has observed. The same turn they keep in loosing their effects, for the soonest converted into salt, must be the soonest exhausted. Thus the reasoning answers exactly to observation: no small confirmation of its truth.

ALL theories, my lord, are liable to objections; altho', in this, not one step has been made without experiment. There is but one objection occurs to me at present: for I shall make no scruple to let you see the weak side of this theory, as well as its strong. It is said that marl laid on ground, a second time, after the effect of the former has been gone, does not enrich it: why should not this marl attract the acid, as well, as the former? We have had, my lord, such short experience, as yet, of this manure, that the fact, I doubt, is not well ascertained. If future experience confirm it, may we not attribute the loss of fertility

fertility to something, the first marl has left behind, that may prove an enemy to vegetation? Marl, by the trials I have made, does not seem all convertible into salt.

ITS manner of acting may, perhaps, afford your lordship some hints in the application and management of it. The observations made on the formation of nitre, in those countries where it is manufactured, may be of use in this point. Great heat, great cold, or much rain hinder the production of it; for the heat dries too much, and the rain washes it away. The summer nights favour greatly its generation. The east and north winds are observed to bring more of that acid with them, than the west, or south. The heat, rain, and winds, tho' not under our command, yet have their times and seasons. All manures are to be exposed in those that suit best in general.

THE management of marl, after it is laid on the ground, may differ according to the intention.

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intention. If its mechanical power is, particularly, wanted, 'tis worth considering whether the plow should not be used directly, that, being mixed with the glebe, it may attenuate the soil more forcibly. If its fructifying power is only expected, it appears probable, that its effects must be stronger, when much exposed to the influence of the air, than if directly buried. Being a stranger to the practice of the farming art, I am not capable of discovering all the advantages, that may, perhaps, be drawn from these experiments. This task I leave to your lordship's judgment, that experience and reasoning may go hand in hand.

S E C T. VI.

MINERAL waters have a subtile spirit, which acts on the whole, as the animal soul does on body. A great part of their agency is owing to its activity. It cannot be shown to the senses; tho', by its effects, the senses, evidently, discover it. And,
when

when it flies off, the remaining water is little better than the common sort.

WHOEVER has looked into those authors, that have given us the marks of this spirit, must have observed, that most of them belong to the air. Air and spirit seem, indeed, intimately united in many waters; for the first carries off the last along with it; and appears to be its vehicle. Yet, as they are by nature different, they ought, if possible, to be separated; and the criterions of both established. Those of air were ascertained before: those of spirit shall be mentioned now.

1. MINERAL water discovers a spirit, if its taste and smell, at the fountain, seems spirituous; but flat and vapid, when exposed to the air for some time. Something very subtle is, by this means, discovered to fly off.

2. IF it appears light on the stomach, when drunk at the well; and heavy, after it has been kept.

3. IF,

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3. IF, in the air-pump, something besides the air flies off; and its smell and taste differ, when examined after.

4. IF the water, drunk at the fountain, has an intoxicating quality. Some of the *German* waters have this to a great degree.

5. IF galls have no effect on the water, after it has stood a few hours. This shews the spirit to be of a steely nature. That of the *German* waters seems to be something very different, and, according to a great chymist *, is, "Aether combined with the universal sulphureous ens of minerals, and pervading the earth." This account of the matter, tho' obscure, shows, that he thinks their spirit different from any preparation of steel. *Dunse*-water possesses all these properties of spirit: and as they decrease, in the same degree with the tincturing quality, it evidently appears to be a chalybeat spirit.

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* Hoffman. de elementis aq. miner. &c. parag. 18.

IN what shape this chalybeat principle exists in mineral waters, is a question that has much perplexed authors. The orthodox opinion is, that it lurks under the form of a salt, or vitriol of steel: the meaning of which is, that the iron has been corroded by an acid, and is still joined to it, just like the salt, or vitriol of steel made by art. This opinion takes its rise, from a resemblance, that salt of steel, dissolved in water, has to steel waters. This resemblance consists in the following circumstances. Their taste is somewhat like. Both turn purple with galls. Both recover their former pellucidity with an acid, and turn purple, again, with an alkali. Both deposite an oker. From this resemblance they concluded, that a vitriol must be contained in these waters. But is not the conclusion somewhat strained? Must the resemblance of mineral waters to this preparation exclude their resemblance to others? or have these authors examined each shape that steel could be put in, so as to say, that this preparation
alone

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alone enjoyed these properties? if not; the consequence will hardly be admitted.

IF common vitriol and that of mineral waters agree in these points; in others they disagree as remarkably. Common vitriol is of a fixt nature; that of mineral waters of a volatile. The first can always be made appear; the last never *. Salt of steel, dissolved in water, loses its tincturing quality, if exposed to the air, for some weeks. But this difference of time shows a great difference in their nature. There is an experiment that seems, at first sight, to favour this side of the question. Oil of tartar *p. d.* dropt into a solution of vitriol, turns it green, and thick. It is, probably, owing to the acid of the steel being attracted by the alkaline salt. No such effect is observed in mineral waters. I, therefore, concluded, that no acid was joined to their steel. But, on a narrow examination, I, afterwards, found, that more vitriol was required

* HELMONT pretends to have extracted vitriol from the Spaw; but none gives credit to him now.

quired to produce this effect, than what could be supposed in mineral waters, and that this experiment could prove nothing.

SWAYED, however, by the other arguments, that great chymist *Hoffman* * denies the vitriol of mineral waters to be the same with the common; but still insists, from the former resemblance, that it must be a vitriol, tho' of a particular kind.

† *Hac urget lupus, hac canis.*

Chrouet is the only author, I have met with, who, not being able to extract vitriol, from these waters, doubts of its existence. But he brings no argument to support his opinion. Nay even relapses ‡ into the common doctrine.

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* *De thermarum et acidularum usu et abusu*, parag. 3.

† *HORAT. satyr. 2. lib. 2. l. 64.*

‡ SPEAKING of the formation of mineral waters, he says,
 “ Supposing a sulphureous earth and an alkaline fixt salt met
 “ together, the acid of the air, attracted by the alkaline
 “ salt, must produce a fermentation and swelling; which
 “ done,

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THIS was my own case, after trying several experiments in vain; till I observed, that *Dunse*-water, by keeping, recovered its steely spirit. This could happen, so far as appeared to me, by no other means, but by a solution of the remaining fixt steel. No acid could join it. A very simple experiment was made to determine this. Five grains of steel filings were infused, for two days, in an ounce of distilled water. This infusion took a deep tincture with galls. Spirit of vitriol turned it pellucid again. Many air-bubbles were observed adhering to the filings of iron, during the time of infusion, which arose on touching the glass. A reddish okery matter fell to the bottom, that increased every day. A scum, too, was observed. This solution, exposed to the air, for some hours, lost its tinging

“ done, the mixture retires within itself and then becomes
 “ the ore of iron. If running water pass through it, while
 “ yet in this soft state, the imperfect ore, and air, arising
 “ from the mixture, will be washed away. A little of the
 “ aerial acid, being joined to the steel, whenever the water
 “ comes to the open air, the acid flies off, and the steel
 “ falls, like an excrement, to the bottom.” This account
 of the affair is neither more, nor less, than a vitriol.

tinging quality. This experiment succeeded with different kinds of water. I found it necessary to cork the bottle well. As this solution has the effects of mineral waters, without being liable to the weighty objections of a supposed vitriol, why should we not conclude, that the steel of mineral waters is like this; minutely divided, but in no wise altered? I can, for my share, see no objection against the justness of this conclusion. Whether these arguments strike equally, against all mineral waters, that contain steel, I leave others to judge.

THIS steely principle disappears, at different times, in different waters. *Dunse-spaw* loses it sooner, than any we find, yet, described. Lose it, is a word I have, purposely, used thro' the whole work; because it answers equally well, whether the chalybeat spirit flies off, or is changed into a fixt steel. To have called it volatile, would have been taking that for granted, which had not been proved; and fixing a prepossession, a thing every
every

SECT. VI. ON DUNSE-SPAW. 159

every enquirer into truth ought to shun. This question is of considerable importance; has not, yet, been determined, so far as I know; and its determination must greatly affect our reasonings on the medicinal operations of these waters.

THE steely spirit appears to be volatile, and not metamorphosed, from these circumstances.

6. A CONSIDERABLE difference is observed in the water, and the chalybeat spirit much longer retained, when it is carried from the well with the necks of the bottles down. Were it changed, the position of the bottles would make no difference. But it must escape, easier, thro' the cork, than glass.

7. IT is gone, before any visible alteration happens in the water; or precipitation is made.

8. A BOTTLE, half full of the water, was shaken, for a quarter of an hour. This had now lost all its tincturing quality; while that, which stood in another bottle, equally full, for the same time, was not sensibly altered.

tered. This shaking should rather have hindered the coalition of particles; stopt the formation of fixt steel; and so have proved an enemy to all change. But, on the system of its being volatile, 'tis easily accounted for, why the exposing it more to the atmosphere, by tossing, should rob it, sooner, of its volatile parts.

9. IT is no small confirmation of this volatility, that the chalybeat spirit of the putrified water is, beyond all doubt, volatile: for no steel is found in the *residuum* of it. Nor is the fixt steel, discovered in fresh water, any objection against the volatility of its spirit: even this endeavours to get off, and rises to the top in form of a scum; but these particles, not being subtile enough, cannot get away, and so become the fixt steel.

THESE, joined to an experiment which follows, that shows a diminution of its weight, while neither air, nor water could possibly escape, afford as great a degree of certainty,

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as the nature of the question will admit, that the chalybeat spirit is volatile.

IF it could be caught, we might, then, fix its weight and properties more certainly. *Hoffman*, for this purpose, advises distillation in close vessels. But how unfit this operation is to lay hold of it, has, already, appeared. I endeavoured to catch it in bladders, well oiled, and ty'd round the mouths of bottles, that contained the water. The air, caught in this way, gave no demonstration of containing a steely spirit: for water, impregnated, again, with it, did not alter with galls. Several other attempts were made: but all in vain. Its subtilty seemed almost beyond that of matter.

A VERY * ingenious attempt has been made to determine the quantity of steel in mineral waters. But as it depends, entirely, on the steel existing, in these, under a vitriolic form, we cannot, having once deni-

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* In a paper by Mr. Monro, vid. med. ess. vol. III.

ed the vitriol, reason on it, or draw any conclusions from it. The experiment, however, is of singular use, as it determines, exactly, the colour different waters take with galls; and gives us a power of communicating that colour to another; an affair of no small importance. On that very ingenious gentleman's scheme I have determined this point already.

If the quantity of volatile spirit is considerable, there should be a sensible decrease of weight. To ascertain this point,

10. I PUT twelve ounces of *Dunse*-water in a phial; corked it well; sealed it over; and weighed it, in exact scales, with the greatest nicety. It stood thus, for twelve hours, till I imagined the volatile spirit had escaped. It was, then, twelve grains lighter. Galls had no effect on it. The same experiment was tried a second time, and I found a loss of seven grains. This difference might have been owing to my holding the bottle for
a few

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a few minutes uncorked. I shall not pretend to say, that this diminution of weight was owing, entirely, to the volatile chalybeat spirit. But it appeared neither owing to air, nor the vapour of water ; for no loss of weight was observed in common water treated the same way. The question is difficult; the determination dangerous.

By volatility naturalists mean no more, than such an attenuation of particles, as makes them fit to mount in the air. How it should do so, is thus explained by the learned Dr. *Friend* *. In dividing bodies the quantity of matter decreases faster than the surface. All matter, therefore, may be reduced to such minute parts, by carrying on the division, that the contents will hold but a small proportion to the surface. Lightness, then, or volatility, which is only a higher degree of it, is nothing else but a small quantity of matter under a large surface. In this way all bodies may become volatile ; and the heaviest made lighter

* Prælectiones chemicæ, cap. de sublimatione.

lighter than the lightest, if we had a full power to divide, as far as we pleased.

THAT particles rendered very minute become volatile, is very evident. The action of putrefaction rendering the salts volatile, and the action of fermentation forming a volatile spirit, by the attenuating power of these two processes, are convincing proofs of it. But that this depends on the cause assigned by *Friend* seems very doubtful. The enlarging of the surface of a body may make it more easily carried up into the air by other bodies, such as fire, air, &c. or it may be the less able to disjoin and separate, by its specific gravity, the particles of air through which it must pass in descending; but I can never see how it can rise of itself on these principles. There seems to be an attraction, or some other power in the air, that is the chief cause of volatility. The great *Boyle* has just given us a hint of it*.

“ But

* Vol. III. of the mechanical origin and production of volatility,

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“ But the account, on which, by its bare
“ presence, or peculiar operations, conduces
“ to the volatilization of some bodies, is a
“ thing very difficult to be determined, with-
“ out having recourse to some notions about
“ gravity and levity, and of the constituti-
“ on of the corpuscles, that compose the air ;
“ which I take to be both very numerous,
“ and no less various. And, therefore, I must
“ not, in these occasional notes, launch out
“ into such a subject, though, for fear I
“ should be blamed for too much slighting
“ my old acquaintance the air, I durst not
“ quite omit the power it has to dispose some
“ bodies to volatility.”

As vast subtilty begets volatility; so great
volatility argues vast subtilty and minuteness.
There are not many things in nature that
seem more so than this spirit. Glass, that
can preserve all odours, confine the effluvia
of diseases, and retain the most volatile chy-
mical salts, allows this to escape through its
pores in a few hours. Art can never arrive
at

at any such manufacture. How powerfully must this spirit operate on the human body! As steel it will have all the effects of that mineral. But as steel, extremely subtilized, it must have them in a great degree.

THE properties of steel are, already, too well known to trouble your lordship with a detail of them. For its great service, it merited the consideration of physicians; and has had it. Its power of opening obstructions; encreasing heat; thinning viscid blood; strengthening the fibres, and acting by diuresis, has already been fully explained by others. No more commentaries are necessary on this head.

THE effects of this martial spirit appear from the following experiment:

II. SOME of the mineral-water was put in a bladder, whose neck, for two inches, was twisted hard; firmly tied; and, then, sealed over with wax. The bladder was put
into

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into water, heated to the degree of the human body. After it had remained there for half an hour, the bladder was opened, but the volatile spirit had escaped.

THIS experiment brings its action home to the very eye; and shews how soon it will penetrate through the coats of the stomach, and the whole body. If, in half an hour, it could pass through the most membranous part of an ox, sure the soft and tender coats of the stomach will not be able to contain it so long. Great part of its action must be exercised in the neighbouring parts. It must soon pervade the whole body.

S E C T. VII.

WATER may be tinctured with minerals, either by their vapour, or subtile particles. We have a probability, that the first may, sometimes, be the case; for the steam of iron, corroded by the spirit of vitriol, if confined, and directed towards pure water,

ter, is found to give it a *Spaw* taste. But this must seldom be the case; and but for a short time. Fermentations, ebullitions, and corrosions in the bowels of the earth cannot last long. The other way where the mineral beds are washed by water, subtilized, and carried along, is, probably, the most general. *Dunse-spaw*, I imagine, is of this kind. A mineral bed of iron, and a marly soil appear sufficient to produce such a spring. This account of its formation is plain and simple; and, therefore, more consonant to the general proceeding of nature.

It will, perhaps, amuse your lordship to run a comparison betwixt this spaw and those of other countries. If we can find any that contain the same principles, they will serve as a foundation for extending the salutary effects of this, which is but yet in its infancy. The analogical reasoning may, then, be used with safety; and the use of the water prescribed with greater certainty. The contents of these waters must be taken on trust from the

Best

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best authors. None is equal of himself to this task.

IN the * descriptions of the *French* mineral-waters, there is an account of one that appears similar to ours. The water of *Provins* is ferruginous. On evaporation a subtile earth, like rust, fell to the bottom. A portion of this formed a circle round the glass, and tasted salt. This salt did not moisten in the air, and appeared to be that portion of sea salt, which does not crySTALLIZE. Its earth was whitish; dissolved in vinegar; and, when ignited, took a red colour. By this description its contents appear to be the same with those of *Dunse-spaw*. But, unluckily, its virtues are not related, nor have I been able, as yet, to come to the knowledge of them.

THE waters of *Aix* are hot; contain sulphur in great quantity; an alkaline salt; some sea salt; and earth that seems to be of the stony kind. A pound of water has twenty five grains of this salt, and five of earth.

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THE

* DU CLOS.

THE different springs of the *Spaw* * differ more in the quantity than quality of their ingredients. The *Pohon* consists mostly of a steel; yet has a little sulphur, and lixivial salt. The *Geronster* has little steel, but much sulphur, and lixivial salt. The *Tonniilet* has a fatty unctuous salt that partakes of allum; sulphur; and fixt iron. The *Sauveniere* contains lixivial salt; sulphur; and iron.

Selter water affords nothing but a pure alkaline salt. It seemed to me, when tasted at the fountain, to be the most spirituous of all the *German*-waters, and to have most of the intoxicating quality.

Pyrmont water has much spirit; a great quantity of steel; some sea salt; and an alkaline substance, whether earth or salt, is left uncertain: most probably the last.

THESE

* THE contents of the *Spaw* are rather taken from Chrouet than Hoffman, because the last does not seem to have made his experiments on the spot, nor does he inform us from what fountain the water was taken: tho' it seems to be from the *Pohon*. He denies a sulphur in that which he examined. The contents of the rest are from him.

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THESE differ very much from the contents of ours. There is one, however, that resembles it, nearly, in its main contents. It gets its name from *Lauchstädiensis*, a place in *Misnia*, belonging to the elector of *Saxony*. The water is heavy at the fountain; but light if kept some hours. With oil of tartar *p. d.* a fine earth is precipitated. It turns purple with galls: deposits an oker: and remains long uncorrupted. Its subtile chalybeat spirit leaves it soon, if exposed to the air, or heat. *Hoffman*, contrary to his common doctrine, asserts, that the steel exists, here, in its pure native form †.

THE virtues of this water are delivered to us at full length. It gives a great appetite; quickens the pulse; and raises a rosy colour in the cheek. 'Tis good for all weakness of the first passages; bad digestion; vomiting of viscid mucus; habitual tendency to looseness;

† In hac autem, marti nativa adhuc constat integritas, neque quippiam alieni sociatum, et hanc ob causam omni detrimentalis et pernicioso effectui destitutus est. De fonte martiato Lauchstädiensi, parag. 11.

ness; general laxity, and weakness of the body; obstructions of the liver, spleen, or any other part; jaundice; chlorosis; stone; scurvy; gout; sciatic; nervous spasms; and hysteric fits. When used as a bath, it cures weakness of the limbs; stiffness from the gout, or other cause; all tumours, and pains in old people from laxity; obstructions of the glands; and defecations of the skin.

LET us now, my lord, come home to our own country, and examine the most famous mineral waters in it. The contents of our two hot springs, *Bath* and *Bristol*, are not, yet, well ascertained. Authors differ much about them, and have left a great deal for further enquiry.

Bath, by experiment, discovers a volatile steel; absorbent earth; a neutral salt; a very little sea salt; and * sulphur.

THE

* SILVER is turned black by the Bath-waters. Sulphurous fumes are emitted on burning the residuum. See Guidot on Bath-waters.

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THE contents of *Bristol* are, yet, more dubious. These, taken from the experiments, and not the conclusions of authors, seem to be a volatile spirit; sea salt; a neutral salt; and a calcareous earth.

Scarborough has been happy in an enquirer. It contains a steely spirit; alkaline earth; a great portion of a purgative neutral salt; with a small quantity of sea salt.

Moffat * discovers a volatile sulphur, or some constituent parts of sulphur; copper; sea salt; and absorbent earth.

Cornhill water has had a reputation for many years; and, therefore, deserves to be examined: more especially as no account is, yet, given of its contents. This spring is exceeding cold; and demands carminatives, and other helps to obviate this quality. It has a blue colour, no smell, and a taste resembling a very weak solution of Glauber salt.

* See an accurate examination of this water by Dr. Plummer med. essays, vol. I.

salt. A scum and okery substance is separated. It is very little heavier than the brook water that runs by.

NEITHER silver, nor iron were discoloured by it. Galls had no effect. Oil of tartar *p. d.* turned it milky. A solution of sugar of lead formed yellow clouds, that deposited a red powder. Quick-silver, dissolved in spirit of nitre, turned it yellow. Spirit of nitre and oil of vitriol made no alteration. Neither did a solution of corrosive sublimate; syrup of violets; or distilled vinegar. A solution of silver in spirit of nitre raised a milkiness, which in a few minutes changed into a sky-blue colour above, and a red below; in a quarter of an hour the mixture was of a deep purple, with a considerable precipitation of a leaden-coloured powder. I am at a loss, my lord, to determine, whether or not this last experiment argues a sulphur. Chymists agree in calling those waters sulphureous, that turn a solution of silver black. But that was not the colour in this experiment. In
frosty

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frosty weather this experiment does not succeed so well; for then, the matter precipitated is only altered in its colour. Worms were not affected by this water. Milk was curdled by it. Soap is not dissolved in it.

THE oker is of a brick colour; and has no taste; effervesces strongly with vinegar; gives no sulphureous smell when put on a red hot iron; nor detonates with nitre. After calcination none of the oker is attracted by the magnet, nor strikes a colour with galls and water. Thus, tho' the oker and scum of *Cornhill* water resembles those of *Dunse*, they appear very different by experiment. All okers have hitherto been imagined of the same irony nature.

WHEN kept a day it loses its peculiar taste. This discovers a spirit in it. Of what nature this spirit is, I cannot say. It is not a volatile sulphur, because the water, deprived of it, still alters a solution of silver in spirit of nitre.

Two *English* pints evaporated gave twenty grains of *residuum*. The second part of sea salt made four grains of this. The other sixteen were composed of a terrestrial substance of a particular nature, nor resembling any yet described. This began to be deposited, before the water was half evaporated; and, therefore, shewed itself to belong to the class of earths. It is white; sparkling; tasteless; scarce dissolvable in the mouth or water; neither acid, nor alkaline; and, when viewed by a microscope, appears to be a congeries of pellucid particles like salt. When the water is evaporated over a strong fire, it covers the bottom of the vessel, like a stony concretion. But, if the heat is gentle, it shews itself in a loose form, as so many white *spiculæ*. As it does not dissolve, like salts, in water, I chuse to class it with earthy substances; tho', in many respects, it appears like the saline. This earth is purgative.

P A R T III.

SECTION I.

MINERAL waters, whose salutary effects are so evident to the vulgar, were esteemed the favours of heaven, and put under the guardianship of the gods. Thus the *Calderinæ* were consecrated to *Juno*; the *Clusinae* to *Æsculapius*; the *Albulæ* to *Hygeia*; and the *Bath* waters to *Minerva*. Great men often shared in the honour, as discoverers, or encouragers of these reservoirs of health. *Aix* waters are called *Graniæ*, from *Granicus* a Roman general who first discovered them, and built a castle for their protection. The *Carolinæ* had their name from the emperor *Charles*. Mankind are, generally, grateful for any service done them; and transmit the names of their benefactors, with honour, to posterity: this acknowledgment is the only one they are capable

pable of ; tho', indeed, a great one. And when I look forward into the annals of futurity, I cannot but imagine your lordship's name stands inrolled there. Nay, more ; you deserve it. To reward industry ; promote manufacture ; and encourage trade, are more useful qualities, than to extend our limits. The first tends to the happiness of mankind ; the latter to their misery. One peoples, while the other dispeoples the world. Thus much we owe you when alive : thus much posterity will pay, when you are no more.

YOUR lordship, tired with the former scrutiny into the contents of this water, will naturally fall into the following train of reflection. " All this may be amusing ; but where
" is the profit ? what avails it, how numerous
" are the contents, if not beneficial to man-
" kind ? Its effects on the human body are,
" alone, to be the measure of its value. On
" these, only, I must form my judgment :
" on these, only, will the world pass sentence
" on

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“ on its reputation and merits. Let me hear,
“ then, of its medicinal benefits : give me
“ facts: produce your vouchers: and, withal,
“ teach me by what methods these salutary
“ ends are best attained.” Enough, my lord.
The value of mineral waters, as of every
thing else in life, ought, certainly, to be mea-
sured by their service to mankind. This is
the only just criterion of our esteem. And
of this good sense is always a sufficient judge:
nor stands it in need of any foreign help.

BEFORE I proceed to the effects of this
water on unhealthful bodies, it seems but
natural to take notice of its effects on health-
ful. There its operations must be more ge-
nuine and uniform. Diseases may alter very
much the solids, the fluids, and the different
secretions. Whoever would argue that this
water has a purgative quality, from observing
such an effect in some morbid cases, or in
cold weather, would find himself grossly mi-
staken. The considering its effects on
healthful bodies seems to be the best me-
thod

thod to ascertain its natural operations on the body. 'Tis, indeed, surprizing that authors have neglected this point. Nor know I any, who has delivered observations, purposely made, on sound bodies.

THE first day that this water is drunk, it, commonly, leaves a particular taste on the tongue ; and produces disagreeable eructations, a nausea, and sickness. These seldom appear after the first day ; and are owing to the stomach not being rightly prepared for the water. Those, who have previously taken a vomit, are seldom, or never, troubled with these complaints.

EVERY one observes that, during the time of drinking the water, their spirits are remarkably raised, and that its effects are in some measure analogous to those of wine. It gives all the flow of spirits that the juice of the grape does, without the subsequent head-ach. I have seen it open the mouth of one who had been silent for months before.

In

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In short it is a most sociable water. This operation is so quick, after drinking some glasses of water, that it can be imputed to nothing but its volatile spirit; and is a strong proof of its speedy agency and penetration, through the smallest vessels.

THE head is sometimes affected by it, as by too much wine. Something like drunkenness is produced. Many have found it difficult to sit on horseback in this condition. But the giddiness lasts not long; and seems to arise from the above-mentioned cause.

IT raises an appetite, and enables the stomach to digest a greater quantity of victuals. This, in some measure, is to be attributed to early rising and exercise; but, still, the mineral water must have its share by washing away the old contents of the stomach, and strengthening its fibres. For the sensation of hunger is supposed to arise from the friction of the bare nerves on the opposite sides:
and

and a great part of digestion is performed by the force of the muscular fibres.

DURING its use, the belly is, generally, somewhat bound. This is an effect of steel, whether prepared by art, or nature. It seems to be owing to the fibres of the intestines being more contracted, and so rendered stronger. By this means they force a greater quantity of the fluid parts of the nourishment into the vessels, while the remainder, more hardened than usual, passes slowly through the intestines. *Hales* has made the contracting power of steel-waters evident by * experiment.

It makes the *fæces* black. This likewise proceeds from the steel. It is, perhaps, effected in some such way, as by the mixture of galls: or by the fixt steel mixt with the fibrous part of our aliment.

It acts as a diuretic, and seldom purges, unless where the *viscera* are unsound, or the weather

* *Vid.* Hæmorrhædicks, experim. 18.

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weather cold. The time alters according to the constitution, and manner of drinking. A fluid scarce deserves the name of diuretic, when no more is secreted, than what was taken by the mouth. Water cannot properly be called a diuretic medicine. But *Dunse-Spaw* has a just title: for the quantity secreted is more, by some ounces, than what was taken in added to the usual secretion. On this quality many of its good effects must depend.

It, generally, makes the pulse more frequent during the time of drinking. At half an hour past five in the morning, my pulse beat an hundred and forty strokes in two minutes. In two hours, having drunk two *English* pints and an half, it rose to a hundred and fifty five. Thus the water quickened it about the eleventh part. This is easily accounted for from its contracting power. The blood must move through the contracted vessels with a greater velocity than before:
as

as a stream, pent up betwixt rocks, is more rapid than when expanded over the plain.

I COULD perceive no change in the fullness or force of the pulse. But we have not such a just measure of these, as the watch is of its frequency.

THE question was several times put to me, whether the water heated: for some such sensation is raised by the drinking of it. The thermometer is the only just criterion of the presence or absence of heat. Our senses are very delusive in this point. I have seen frequent instances of this deception. A person, in a cold fit of an ague, is considerably hotter, than in good health. The thermometer is the only test, then, of real heat; and, to that, I applied for a determination. No increase of heat was observed on drinking two *English* pints and an half.

WHAT effect it has on perspiration I was not able to discover, for want of a proper instrument

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strument to reduce that secretion to weight and measure. 'Tis probable, however, that it is considerably increased, from the greater vigour of the vessels, frequency of the pulse, and diminution of the intestinal discharge; for the increase of the reinal cannot make up for the decrease of the last. Besides, if the invisible perspiratory matter was not in proportion to the quantity of aliment, the vessels would very soon be too full.

IT is very common for those in good health to have pustular eruptions over the skin, on their first drinking the water. Mr. *Hood* was a remarkable instance of this among many. He went to the well to bear some friends company. After he had drunk the water six days, large boils appeared over his body, and increased to such a degree, that he was confined to his bed. When they were retiring, he drank more water; but none, afterwards, appeared, the inflammatory matter being exhausted. This cutaneous eruption ceasing after a certain time shows,

A a

that

that the water does not generate, but expel the noxious humours. Whether this is effected by the increased force of the vessels, or in some other unknown way, I shall not pretend to determine. But sure I am the effect must be salutary. How far, in these luxurious times, it may be proper for every one to purify, for some weeks each year, especially for those mewed up in large cities, I leave common sense to determine for itself. If the wheels of a watch are cleaned at stated times, they will never stop, till wore out, naturally, by attrition, or damaged by some external accident. This is an effect, so far as I know, not yet related of any mineral water.

I SHALL not scruple to acquaint your lordship with its ill effects, as well as its good. If drunk, when any fresh cold is caught, it makes the person hot, feverish, and uneasy: and no wonder, when its natural effect is to make the pulse more frequent. This is not to be laid to the account of the water, but to that of its
its

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its injudicious use, while the body is really in an unhealthy state.

I HAVE known two instances of its producing twitchings and gentle spasms in the stomach. These seemed owing to the mucus that guards the nerves, being washed away, by which the subtil, active, and irregular particles of steel made too strong impressions. What confirms this reasoning is, that, after desisting for some days, till the mucus is formed, the water may be safely, again, used. Some persons may have such delicate and irritable nerves, as to be more liable to these pains than others.

S E C T. II.

IT is much to be regreted, that public records have not been kept of all the effects, that appeared upon diseases on the use of mineral waters. It would be of service to mankind, if every remarkable case was distinctly wrote and hung up in the church.

These

These would be as so many physicians to give advice to those who pleased to consult them. This, my lord, is no ideal scheme. It has been done. The ancients, we know, when they escaped any great sickness, or other danger, hung up accounts of the affair in their temples. These, from the vow made during the danger, were called votive tables; and are said to have supplied *Hippocrates* * with a number of his excellent histories and prognostics. Shall we, then, of a purer religion, fail in our acknowledgments and gratitude? surely not: for doing good to man is the highest gratitude to the Supreme Being.

It would have been more for our benefit, had the writers on mineral waters, instead of telling us that they cure such diseases, given us the plain naked history of these cures, and left every one to judge for himself. These paintings represent the whole scene to the eyes; let the reader into several secrets, that the narrator is not aware of; answer a thousand

* Vid. Plin. nat. hist. lib. 29.

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land questions; and act the whole over again. While the bare information of being good for this, or for that disease, touches only the ear, and gains but little credit.

THIS method I shall follow, as the justest way of dealing with your lordship. The effects of *Dunse-Spaw* shall be laid before you: I will only act the part of a narrator: your own judgment shall determine. To proceed in this way is to proceed impartially.

FACT is often in danger of losing credit by bad reasoning. That these histories may not suffer, in this way, I shall deliver them, as they came from the persons themselves, and leave the theory to be managed as you please. What may please me, may not please your lordship. Besides, the greatest physicians are not agreed about the causes of diseases; nor ever will. The speculation is too abstruse to admit of any great certainty. If, then, we are ignorant of the causes of diseases, our reasoning on the action of mineral waters,

waters, in removing these causes, must be very uncertain.

As this well is still in an infant state, no great number of these histories can be expected. Nor have they all come to my knowledge. Even in those that have, the curious cannot be satisfied in the minute circumstances, as I had them by relation. Order requires that we begin with the diseases of the first passages, where its greatest power must be exercised, being more immediately applied there.

IT has been found serviceable in flatulencies of the stomach. A young lady, troubled with frequent eructations, swelling of the stomach, and an uneasy choking sensation, was cured of these symptoms by this water.

GREAT benefit has been found, where the stomach was so weak, as not to be capable to digest, or even retain the aliments. *Mrs. Murdoch of Ayton* had been afflicted with

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with a pain of her stomach for many years, and taken many medicines with little success. In the spring 1749 she drank *Dunse*-water, and found herself better. But in the *September* following she was worse than ever; and her disease kept on the increase all the winter and spring following. She was now emaciated, weak, and scarce able to walk. Her stomach rejected all kind of food, even the lightest: for she had abstained from all kinds of flesh for a long time. Her pain was so great after eating, that she was generally obliged to force up her victuals before they had undergone any change. This disagreeable task made her almost abstain from victuals. She had no feverish, or nervous symptoms. In this condition she went to *Dunse*-well about the 5th of *April*. She drank a bottle of water every morning, at first in bed. The pain of her stomach quickly abated; in a few days she eat her victuals with an appetite; retained, and digested them. When she was able she went to the well; and,

and, in six weeks recovered her health and strength.

Two young gentlemen, who had the same symptoms, tho' not of so long continuance, were relieved from them by the use of this water.

THE following is an instance of its not suiting every case. — *Wight of Deadriggs*, a boy about fourteen years of age, had been troubled, for four years, with continual vomitings. He drunk of *Dunse-water* for five weeks without any success. When I saw him he was much emaciate, and without fever. Frequent giddiness and pale urine showed the disease to be nervous, and his vomiting symptomatic. And, accordingly, he was cured in a few weeks by nervous medicines.

WHEN it thus operates on the stomach, it cannot miss to have analogous effects on weak intestines. This disease is known by
great

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great flatulency, liquid *fæces*, and tendency to a purging on the least cold. A gentleman, in these circumstances, found himself, after drinking this water, less liable to those symptoms afterwards.

LET us follow the water into the habit of the body, and view its operations in opening obstructions of the different viscera. Steel waters have always been reckoned good for the spleen and liver. *John Millar* had been troubled, for many months, with a heavy pain in the place where the spleen is situated, which symptom was augmented by hard labour. Sometimes a swelling was perceived outwardly. On drinking this water the pain went off.

A GENTLEMAN, who had laboured under the same symptoms for four months, had been blooded frequently, and blistered on the part, without any considerable relief, was eased of all his complaints in nine days.

THE reverend Mr. *Home* minister of *Fogo* was seized in *February* 1742 with a great pain, and fulness in the region of the liver; frequent vomitings; bileous eructations; costiveness; and a degree of fever, with heat, thirst, and restlessness. He did not get so free from these symptoms, but that he was troubled with frequent returns of them for six years. About the middle of *July* 1748 he was seized in the old way with the additional symptoms of the jaundice. When all these, except the pain and yellow colour, were a little abated by proper evacuations, he began to drink the water. All the symptoms went off in three weeks. Nor has he ever felt, for these two years past, the least degree of those symptoms, that had stuck by him for six years before.

FOR the glandular obstructions in the king's evil it has been found of service. Two or three cases might be produced in its favour. *David Wight* a boy about twelve years of age had laboured under this disease for six years.

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years. There was a running and hardness from the maxillary glands in both sides. He had tried *Moffat* and *Corstorphin* waters with advantage; but as the swelling and hardness was never carried off, the running always returned. He came to *Dunse* about the middle of *July*, and drank a bottle of water every morning. It acted as a diuretic. In a month the sores were all dried up, and the part quite soft. He continued drinking the water for two months longer, and is at present free from his former disease. As *Moffat*-water has stood the test of many years, and wrought remarkable cures in this disease, we are in justice bound to give it still the preference: at least, until *Dunse* can produce as many. The experience of many years must weigh down that of a few.

INSTANCES of its curing the scab have been numerous. In some of these it has been little less virulent than the leprosy, and had stood its ground against all medicines for many years. This water forces the eruption
out

out in greater quantity at first, and never ceases, till it has ejected the whole matter.

ITS effects in the scurvy are these. Mrs. *Smith* of *Dunse* had a dry scorbutic scurf over her legs and arms, that could be scraped off with a knife. The parts below were fiery and itchy. After trying medicines with no success, she drank the water for six weeks. In the *January* following her disease went off, and her skin turned soft and smooth. I must inform your lordship that this disease often retires after the medicines, that wrought the cure, have been left off. Nature when strengthened performs the rest herself.

----- had been troubled with a swelling and crusty scab over her face. Her gums were tumid; her teeth loose; her joints and head pained. The corrosive matter separated from her face attacked the septum of her nose and bred ulcers there. On drinking the water for two months, the swelling of her face fell; the scabs disappeared, and the ulcers healed.

Elisa.

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Elisabeth Anderson of *Eymouth* was, in *January* last, covered over with most inveterate white scales from head to foot. She lost her appetite; turned sick; weak; unable to walk, or endure the least motion. She sent for the water, and drank it at the rate of four *Scots* pints in the day. In a little time she was freed from all her complaints.

SEVERAL scorbutic spots of many years standing have been carried off by this water. One particularly in the palm of the hand, that mattered, and gave great trouble to the gentleman that had it.

BUT the compleatest and furthest advanced scurvy was that of ----- . He had ulcers in his gums and tongue; livid spots in his legs; loose teeth; sleepiness; and swelling of his legs: symptoms of this disease in its highest degree. But the use of this water in a few weeks carried them off.

Its

ITS effects in nervous cases are yet dubious. Some have been the better for its use; while others have not. Future experience must fix the limits. A gentlewoman in *Eymouth* had always a tendency to a nervous disorder; which appeared more plainly in 1745, after she had beheld the terrors of a storm at sea. The disease continued on the increase till *October* last. She had, then, frequent startings and shakings over all her body, preceeded by an aking of the parts. A numbness and insensibility, often, seized her from her loins downwards; which was followed by a quick sensibility and tenderness of the parts. She complained of spasms in her breasts; loss of appetite; clear urine; salt spittle; and a sharp humour from her nose. The muscles of her forehead, eyes, and mouth were, frequently, convulsed; and distorted her face. Her jaw was often forced open to admit victuals; and, after all, she could neither chew, nor swallow them. Painful and disagreeable thoughts arose with the paroxysm. In this state she came to *Dunse-well*. After
drinking

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drinking the water three weeks, she recovered her health, and has continued for six months quite well.

It has been tried with advantage in fresh paralytic disorders. Mr. -----, far advanced in years, was, last winter, attacked with a paralytic disorder. His legs had almost lost their feeling, strength, and motion. His arms were little better. His tongue refused to do its office. His internal faculties had felt the disorder. The returning heat of summer gave him some ease. He began in *July* to drink the water. The heat returned gradually into his extremities. In six weeks he could walk to and from the well, could write, and had the full use of his tongue and internal faculties. During his cure he passed a great quantity of a sandy-like substance. He had during his life some touches of the gravel. Was that substance, pre-existing in the blood under another shape, the cause of his distemper, when deposited on the nerves? It might be so.

Alexander

Alexander Wedderspoon of *Prestonpans*, seventy five years of age, was seized with a paralytic disorder in *January* last. From his loins downwards he had a shaking, want of feeling, and weakness. When he came he could scarcely creep down to the well. I saw him four weeks after he had drunk the water; and, then, he was quite recovered.

IN chronic rheumatisms it has been tried, sometimes with success, sometimes without. *John Henderson* troubled with rheumatic pains in his shoulders and joints was cured in three weeks.

ITS effects in the gout has, scarcely, been yet tried. *Mr. Fordyce* had some irregular attacks of it before he began the use of this water. A month after he was attacked with a regular fit of the gout. After the fit was over he began the use of the water again; during which time he continued well.

IN

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IN old coughs with rough viscid defluxion this water appears to be of service. But in recent colds it has been found prejudicial.

IN an atrophy it had no effect. A young woman, about twenty years of age, of a pale habit, had nightly sweatings, and a swelling of her legs, with a general wasting. She drank the water for a fortnight without any effect.

IN dropfical cases mineral waters are accounted pernicious. The following instance is, therefore, very remarkable.-----*Brown of Millerston* was seized with an ague last harvest, which was succeeded with a dropfical swelling in his belly and legs. His belly was very much swelled when he came to the well. I saw him about a month after he had drunk the water. The swelling of his legs was then quite gone, and his belly somewhat softer. The fluctuation was plainly felt. I saw him at different times; and found the swelling less and less every time. He

continued the use of the water for four months, and went away cured, as I^r was informed, for I did not, then, see him. He drunk the water twice a day; and thought that he evacuated more than he drunk.

IT has done considerable service in the stone and gravel. The reverend Mr. *Carlisle* of *Prestonpans* was seized, in *November* 1748, with a violent pain in one kidney, and a vomiting. He took great quantities of soap without success. In that kidney there was a constant dull pain, that increased on any fatigue. In 1749 he began to use *Dunse*-water twice a day. The second day he passed a white sharp sand, and so was delivered from the long continued pain.

Robert Norrie of *Dunse* had been troubled with nephritic symptoms for five and twenty years. He had suffered much pain. He was carried to the well, and the first three days passed three stones: after this he was easy and walked down on foot. A fortnight after

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after he had a severe fit. In the whole he has been much easier since.

SERJEANT *Weir* of *Dunse* had been asthmatic for many years, and troubled with the gravel for eighteen months. At first he was scarcely able to walk to the well, but in three weeks was able to walk three miles. He passed several stones. His asthma was much relieved too.

SERJEANT *MacQuin* of *Dunse*, being reduced very low by the flux in *Germany*, was obliged to ly, for twenty days, on his back. After this he felt a dull heavy pain in his right kidney, with clear urine, tho' often bloody after fatigue, severe reachings and twitchings of his belly. In 1747 he rode down to the well every day. He, then, perceived much sandy sediment and some small stones. In five weeks he could walk with ease. The symptoms have never troubled him since, except on coughing or any severe motion; then the place feels sore.

IN

IN diseases of children it has been found of use. It has been tried with success for worms. The * experiment mentioned before shews it has a specific quality in this disease. The absorbent earth must, likewise, be of advantage in correcting the acidity formed in their weak stomachs. Children fifteen months old have drunk it with success.

THIS water seems a medicine well calculated for those who have lost appetite, strength, and spirits from severe study, too close an attention to business, or the sedentary life of a populous city.

IF we reason from analogy, this water should be hurtful to those who have great and old schirrous obstructions in any of the *viscera*; to the pthical; the hectic; or the costive. Time and experience can alone confirm these suspicions.

THE water outwardly applied dries all scabby eruptions. As there is no bath, its effects

* Vide sect. 2. part 1.

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effects are but little known in this way. The scum has been of service to weak eyes, and watry swellings of the legs: it seems to have a penetrating astringent quality.

WHEN I look back on these few cases, I cannot but think, that they contain many remarkable cures; too remarkable, indeed, to lie buried in silence. They are facts that speak for themselves; that argue with most convincing rhetoric; that stand in need of no embellishing theory; and, therefore, had none.

S E C T. III.

EVERY art and profession has not only its instruments, but its rules for the management of them. The pipe cannot alone make the music. The stops must be managed in the manner laid down by the proficient of the art, e're harmony can arise. Rules, then, my lord, are absolutely necessary to attain the salutary effects of mineral waters.

waters. There is a certain preparation, a certain quantity, a certain time, and a certain method of life that will make the patient reap the greatest advantage. In whatever side we err, we miss our mark.

THE preparatory method to waters seems, in general, too severe; especially to the steely sort. To enfeeble, by repeated purgatives, when the water operates by bracing and strengthening, is surely against common sense. A gentle preparation, however, is necessary.

IF the person has too great a fulness of the vessels; a youthful sanguinary constitution; a suppression of natural discharges; a full, or hard pulse; swelling of his veins; if he has eat, or drunk too plentifully before, and used but little exercise; if troubled with severe pains in any place; in these circumstances he ought to lose some blood. For, as the circulation is quickened by the water, there is danger lest the vessels be choked up, and a fever follow. Besides, in this state of the fluids, the secretions never go well on.

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on. If bleeding is necessary in these circumstances, it is bad for the weak ; pale ; those that have a low soft pulse ; and the old.

A VOMIT seems in all cases absolutely necessary. The viscid matter in the stomach stops the operation of the water, and, being carried along with it into the circulation, contaminates the fluids. A vomit is, therefore, necessary. Without it a sickness and giddiness attends the drinking. So strongly does nature point out this medicine.

FOR the same reason the intestines demand to be cleaned. But here we may answer two intentions. As the water is to operate in the diuretic way, it is necessary that the renal passages should be cleared, to give it a free exit. Both these designs may be answered at once by manna and cream tartar, or Glauber salt. But if the constitution be very low, or the intestines weak, rhubarb is more advisable. If too great a quantity of bile abounds, tamarinds are preferable to either.

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This shews how ridiculous it is to make one purgative serve all constitutions and all designs. One dose, in general, will be found sufficient. All severe purges ought to be shunned; for they pervert the tone of the intestines; and are, in every shape, unfit to precede mineral waters.

THE morning is the proper time for the use of mineral waters. The stomach and intestines are freer from contents, and the vessels emptier, at that time, than at any other. They have, likewise, little labour, the chyle being already changed. The water must, therefore, act more powerfully on the first passages and vessels.

THE experiments on the water must make every one sensible, that its genuine effects are only to be had at the fountain-head. It is losing, every moment, its most valuable parts, and that small degree of heat it has. The sea salt, absorbent earth, and water remain, but the volatile steely spirit cannot be retained.

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ed. Besides, shaking appears by experiment to assist its escape. Whoever has drunk it at the fountain, and at a distance, must be sensible of a great difference in its lightness on the stomach.

As the human body does not agree with sudden changes, 'tis proper to begin with small quantities, and to arise, by degrees, to the just dose. This must, always, be proportioned to the constitution. The young and robust demand a greater quantity, than the old, the tender, or those of delicate nerves. Men, in general, can bear more than women. So far as a rule can be given in such a varying subject; four *English* pints are sufficient for the strongest man, and three for a woman.

GENTLE exercise, during the drinking, is requisite to assist its operation. Walking, riding in any vehicle, or on horseback, are proper. The last is preferable to the others. All violent motion, that may raise a heat,

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ought to be shunned: for the tumult disturbs secretion.

THAT its chilness and wind may have no bad effect, it is customary to use carvy, ginger-tablet, or confected orange-peel. This may be necessary to those of delicate nerves, but is only a matter of form to the strong, as the water is neither cold, nor windy. A little may, however, assist the stomach in the expulsion of the water, but a great deal is by no means advisable. Some, on account of too delicate nerves, cannot bear mineral waters cold, and therefore have been in use to warm them. But as this has, of itself, a degree of warmth, few will find any inconvenience from it. If there be any such to whom the coldness gives pains in the stomach, they may heat it quickly, by putting the glass in some warm water. But it will always be the worse for this.

THERE is nothing more necessary than an attention to the way of life, during a course
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of mineral waters. A great quantity of victuals give the first passages and vessels too much fatigue to receive any benefit from the water. And too great a quantity of fermented liquors, by thickening and inflaming the blood, counteract its effects. Moderation, in both these points, appears, to common sense, very requisite. An excess in eating must be guarded against; for the stomach seems to be strengthened, by the immediate application of the water, more than the rest of the body; and, therefore demands and digests more, than the vessels are able to bear, or expel. Thus a plethora will soon succeed if no moderation is used. The quality must, likewise, be considered. Whatever of vegetables, fish, or flesh is heavy, fat, tough, viscid, windy, salted, or smoaked, must be shunned; that the stomach and vessels may have as little trouble with the formation of chyle as possible. The lightest food is the best. Most people, from their own experience, are judges of that.

IF I advise moderation in the use of strong liquors, I am far from recommending total abstinence. Regard ought always to be had to the usual way of life. Custom is so prevailing, that nature cannot want what she has been used to. A sudden change would be very improper under this course. The stomach might be apt to fail. Punch appears not to be the properest liquor, as it contains an acid, that will join directly to the absorbent earth, and stop its effects on the body. White wines, that have no acidity, are the best.

THE management of the passions is to be considered in this scheme. What effects these powers of the mind have over the body, every one must have observed. It is, indeed, only the unsociable passions that we are to dread. The sociable must be carried to a great excess, e'er they can do any harm. When anger, envy, jealousy, or any of that unruly tribe once take possession of our breasts, the body suffers with the mind, and
soon

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soon becomes as irritable. Every slight smart, each breath of wind, which, at another time, would have passed unheeded, is now felt, and agonizes the whole frame. This seems a punishment fixt to them by the author of nature : and affords no bad argument for their general moderation ; but more especially at the present time, when they may shake the frame, so as to undo all that the mineral water has done. Ease of mind, and cheerfulness of temper, promote the salutary effects of mineral waters.

It is customary, in using the *German-waters*, to take purgatives frequently. I would by no means recommend such a practise here. If any person is uneasy under the natural effects of the water, a gentle laxative may be used,

THERE can be no time fixt for the course. That depends entirely on the varying circumstances of constitution and disease. This
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much, however, may be said, that the use of the water ought to be continued, for some time, after the cure is seemingly performed:

It is a common custom, after a course of mineral waters, to take some purgatives. *Hoffman* alledges that the *German* waters are apt to remain, for many days, in the folds of the intestines, if not carry'd off in this way. I could never observe this in *Dunse*-water. No necessity, therefore, appears for such a course. If any, however, chuses, from preconceiv'd opinions, to conclude in this manner, rhubarb will destroy the good effects of the water, less than any other medicine.

If from cold, feverishness, or any other cause, the water does not pass freely, the person is to abstain from it directly. Purgative waters force their own way along the intestines, and a great share of them is never mixed with the blood. But the diuretic, before they are evacuated, must entirely mix with
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the blood. They have but one exit; and if they are denied that, the vessels must be swelled and choaked up. A new addition every day may prove dangerous. In this case bleeding is necessary. It will empty the vessels, and assist the secretion. Glauber salts will force a passage, and open the urinary ducts.

MINERAL waters ought never to be drunk about the time of any critical evacuation. Nature, then, is easily diverted from her work, and may take a wrong course, if another outlet be opened.

IT merits consideration, whether the water might not be used, in several cases, with greater success, if mixt with milk, or whey. This method is followed in several of the *German* waters with great advantage. Where the nerves are delicate and irritable; where the lungs are touched with cough, or asthma; where there is a tendency to an universal consumption; a languid pulse; spasmodic,
or

or hysteric affections ; loss of strength ; vitiated digestion ; gout ; scurvy ; gravel ; this method seems reasonable. Future trial, and experience must determine these points.

WE are now come to a conclusion. If I have detained your lordship too long from the interests of mankind, it is, my lord, by endeavouring to serve them. This may, in some measure, alleviate my fault. But that a design to benefit particulars may not injure the whole, I shall take leave of your lordship, and own myself with the highest respect,

My Lord,

Your Lordships, &c.



